SOCIAL HABITATIONS.

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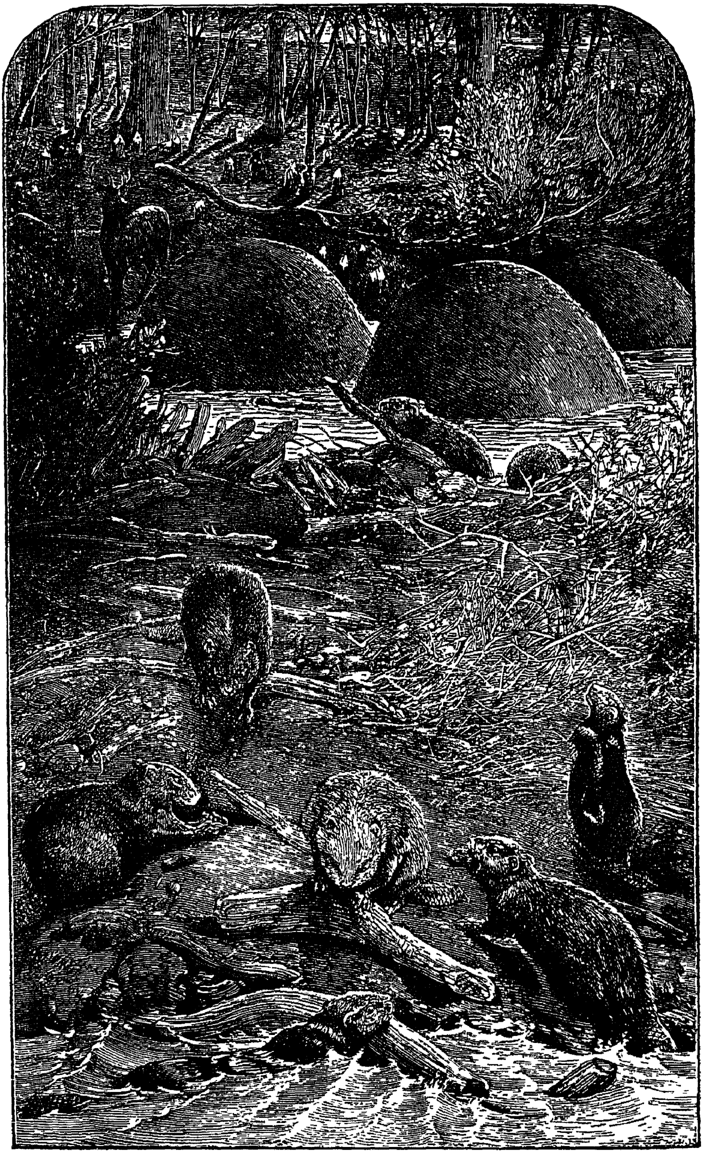


THE BEAVER AND ITS HOME.

SOCIAL HABITATIONS

AND

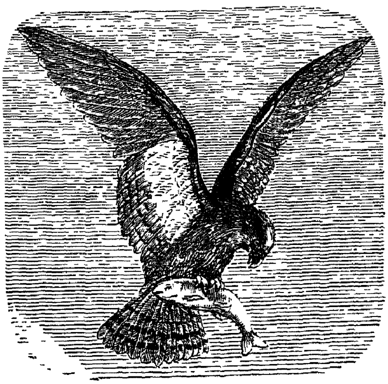
PARASITIC NESTS

FROM "HOMES WITHOUT HANDS"

BY THE

REV. J. G. WOOD, M.A., F.L.S., &c.

With 18 Illustrations



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SOCIAL HABITATIONS.

CHAPTER I.

SOCIAL MAMMALIA.

The BEAVER—Its form and aquatic habits—Need for water and means used to procure it—Quadrupedal engineering—The dam of the Beaver—Erroneous ideas of the dam—How the Beaver cuts timber—The Beaver in the Zoological Gardens—Theories respecting the Beaver's dam—How the timber is fastened together—Form of the dam, and mode of its enlargement—Beaver-dams and coral-reefs—The house or lodge of the Beaver—Its locality and structure—Use of a subterranean passage—How Beavers are hunted—Curious superstition—"Les Paresseux."

WE will now describe the SOCIAL HABITATIONS, and give precedence to those which are constructed by Mammalia.

Of the Social Mammalia, the BEAVER takes the first rank, and is the best possible type of that group. There are other social animals, such as the various marmots and others; but these creatures live independently of each other, and are only drawn together by the attraction of some favourable locality. The Beavers, on the other hand, are not only social by dwelling near each other, but by joining in a work which is intended for the benefit of the community.

The form of the Beaver is sufficiently marked to indicate that it is a water-loving creature, and that it is a better swimmer than walker. The dense, close, woolly fur,

defended by a coating of long hairs, the broad, paddle-like tail, and the well-webbed feet, are characteristics which are at once intelligible. Water, indeed, seems to be an absolute necessity for the Beaver, and it is of the utmost importance to the animal that the stream near which it lives should not run dry. In order to avert such a misfortune, the Beaver is gifted with an instinct which teaches it how to keep the water always at or about the same mark, or, at all events, to prevent it from sinking below the requisite level.

If any modern engineer were asked how to attain such an object, he would probably point to the nearest water-mill, and say that the problem had there been satisfactorily solved, a dam having been built across the stream so as to raise the water to the requisite height, and to allow the superfluous water to flow away. Now water is as needful for the Beaver as for the miller, and it is a very curious fact, that long before millers ever invented dams, or before men ever learned to grind corn, the Beaver knew how to make a dam and insure itself a constant supply of water.

That the Beaver does make a dam is a fact that has long been familiar, but how it sets to work is not so well known. Engravings representing the Beavers and their habitations are common enough, but they are generally untrustworthy, not having been drawn from the natural object, but from the imagination of the artist. In most cases the dam is represented as if it had been made after the fashion of our time and country, a number of stakes having been driven into the bed of the river, and smaller branches entwined among them. The projecting ends of the stakes are neatly squared off, and altogether the work looks exactly as if it had been executed by human hands. One artist seems to have copied from another, so that the error of one man has been widely perpetuated by a series of successors.

Now, in reality, the dam is made in a very different manner, and in order to comprehend the mode of its structure, we must watch the Beaver at work.

When the animal has fixed upon a tree which it believes to be suitable for its purpose, it begins by sitting upright, and with its chisel-like teeth, cutting a bold groove completely round the trunk. It then widens the groove, and always makes it wide in exact proportion to its depth, so that when the tree is nearly cut through, it looks something like the contracted portion of an hour-glass. When this stage has been reached, the Beaver looks anxiously at the tree, and views it on every side, as if desirous of measuring the direction in which it is to fall. Having settled this question, it goes to the opposite side of the tree, and with two or three powerful bites cuts away the wood, so that the tree becomes overbalanced and falls to the ground.

This point having been reached, the animal proceeds to cut up the fallen trunk into lengths, usually a yard or so in length, employing a similar method of severing the wood. In consequence of this mode of gnawing the timber, both ends of the logs are rounded and rather pointed, as may be seen by reference to the frontispiece. In the Zoological Gardens may be seen many excellent examples of timber which has been cut by the Beaver: the logs and cut stumps which are given in the frontispiece were sketched from those objects.

The next part of the task is, to make these logs into a dam. Now, whereas some persons have endeavoured to make the Beaver a more ingenious animal than it really is, and have accredited it with powers which only belong to mankind, others have gone to the other extreme, and have denied the existence of a regularly built dam, saying that it is entirely accidental, and caused by

the logs that are washed down by the stream, after the Beavers have nibbled off all the bark.

That this position is untenable is evident from the acknowledged fact that the dam is by no means placed at random in the stream, just where a few logs may have happened to lodge, but is set exactly where it is wanted, and is made so as to suit the force of the current. In those places where the stream runs slowly, the dam is carried straight across the river, but in those where the water has much power, the barrier is made in a convex shape, so as to resist the force of the rushing water. The power of the stream can, therefore, always be inferred from the shape of the dam which the Beavers have built across it.

Some of these dams are of very great size, measuring two or three hundred yards in length, and ten or twelve feet in thickness, and their form exactly corresponds with the force of the stream, being straight in some parts, and more or less convex in others.

The dam is formed, not by forcing the ends of the logs into the bed of the river, but by laying them horizontally, and covering them with stones and earth until they can resist the force of the water. Vast numbers of logs are thus laid, and as fast as the water rises, fresh materials are added, being obtained mostly from the trunks and branches of trees which have been stripped of their bark by the Beavers.

The reader will remember that many persons have thought that the dam of the Beaver is only an accidental agglomeration of loose logs and branches, without any engineering skill on the part of the animals. There is some truth in this statement, though the assertion is too sweeping. For, after the Beavers have completed their dam, it obstructs the course of the stream so completely

that it intercepts all large floating objects, and every log or branch that may happen to be thrown into the river is arrested by the dam, and aids in increasing its dimensions.

Mud and earth are also continually added by the Beavers, so that in process of time the dam becomes as firm as the land through which the river passes, and is covered with fertile alluvium. Seeds soon make their way to the congenial soil, and in a dam of long standing, forest trees have been known to grow, their roots adding to the general stability by binding together the materials. It is well known that the fertile islands formed on coral reefs are stocked in a similar manner. Originally, the dam is seldom more than a yard in width where it overtops the water, but these unintentional additions cause a continual increase.

The bark with which the logs were originally covered is not all eaten by the animals, but stripped away, and the greater part hidden under water, to serve for food in the winter time. A further winter provision is also made by taking the smaller branches, diving with them to the foundations of the dam, and carefully fastening them among the logs. When the Beavers are hungry, they dive to their hidden stores, pull out a few branches, carry them on land, nibble away the bark, and drop the stripped logs on the water, where they are soon absorbed by the dam.

We have now seen how the Beavers keep the water to the required level, and we must next see how they make use of it. The Beaver is essentially an aquatic mammal, never walking when it can swim, and seldom appearing quite at its ease upon dry land. It therefore makes its houses close to the water, and communicating with it by means of subterranean passages, one entrance of which passes into the house or "lodge," as it is technically named,

and the other into the water, so far below the surface that it cannot be closed by ice. It is, therefore, always possible for the Beaver to gain access to the provision stores, and to return to its house, without being seen from the land.

The lodges are nearly circular in form, and much resemble the well-known snow-houses of the Esquimaux, being domed, and about half as high as they are wide, the average height being three feet, and the diameter six or seven feet. These are the interior dimensions, the exterior measurement being much greater, on account of the great thickness of the walls, which are continually strengthened with mud and branches, so that, during the severe frosts, they are nearly as hard as solid stone. Each lodge will accommodate several inhabitants, whose beds are arranged round the walls.

All these precautions are, however, useless against the practised skill of the trappers. Even in winter time the Beavers are not safe. The hunters strike the ice smartly, and judge by the sound whether they are near an aperture. As soon as they are satisfied, they cut away the ice and stop up the opening, so that if the Beavers should be alarmed, they cannot escape into the water. They then proceed to the shore, and by repeated soundings, trace the course of the Beavers' subterranean passage, which is sometimes eight or ten yards in length, and by watching the various apertures are sure to catch the inhabitants. This is not a favourite task with the hunters, and is never undertaken as long as they can find any other employment, for the work is very severe, the hardships are great, and the price which they obtain for the skins is now very small.

While they are thus engaged, they must be very careful not to spill any blood, as if they do so, the rest of the Beavers take alarm, retreat to the water, and cannot be captured. They also have a curious superstitious notion,

which leads them to remove a knee-cap from each Beaver and to throw it into the fire. They would expect ill-luck were they to omit this ceremony, which is wonderfully like the custom of our fishermen of spitting into the mouth of the first fish they catch, and on the first money which they take in the day, "for luck."

Generally, the Beavers desert their huts in the summer time, although one or two of the houses may be occupied by a mother and her young offspring. All the old Beavers who have no domestic ties to chain them at home, take to the water, and swim up and down the stream at liberty, until the month of August, when they return to their homes. There are, also, certain individuals called by the trappers "les paresseux," or idlers, which do not live in houses, and make no dam, but abide in subterranean tunnels like those of our common water rat, to which they are closely allied. These "paresseux" are always males, and it sometimes happens that several will inhabit the same tunnel. The trapper is always pleased when he finds the habitation of an idler, as its capture is a comparatively easy task.

CHAPTER II.

SOCIAL BIRDS.

The SOCIABLE WEAVER BIRD and its country—Description of the bird—Nest of the Sociable Weaver—How begun and how carried on—Materials of the nest—The tree on which the nest is built, and its uses—Dimensions of the nest and disastrous consequences—A Hottentot and a lion—Supposed object of the social nest—Average number of inhabitants—Analogy with Dyak houses—Enemies of the Sociable Weaver: the monkey, the snake, and the parrakeet.

WE now come to the SOCIAL BIRDS, one of which is as pre-eminent among the feathered tribes as is the Beaver among mammalia. This is the SOCIABLE WEAVER BIRD, sometimes called the SOCIABLE GROSBEAK.

This species is allied to the Weaver Birds, and makes a nest which is no whit inferior to the nests of the ordinary Weaver Birds. The Sociable Weaver Bird is a native of Southern Africa, and in some places is very plentiful, its presence depending much upon the trees which clothe the country. It is not a large bird, measuring about five inches in length, and is very inconspicuous, its colour being pale buff, mottled on the back with deep brown.

The chief interest about the species is concentrated in its nest, which is a wonderful specimen of bird architecture, and attracts the attention of the most unobservant traveller. Few persons expect to see in a tree a nest which is large enough to shelter five or six men; and yet that is often the case with the nest of the Sociable

Weaver Bird. Of course so enormous a structure is not the work of a single pair, but, like the dam of the Beaver, is made by the united efforts of the community. How it is built will now be described.

SOCIABLE WEAVER BIRD

Large as is the domicile, and capable at last of containing a vast number of parents and young, it is originally the work of a single pair, and attains its enormous

dimensions by the labours of those birds which choose to associate in common. The first task of this Weaver Bird is to procure a large quantity of the herb which really seems as if made expressly for the purpose. This is a grass with a very large, very tough, and very wiry blade, which is known to the colonists as Booschmannie grass, probably because it grows plentifully in that part of Southern Africa where the Bushmen or Bosjesmans live.

They carry this grass to some suitable tree, which is usually a species of acacia, called by the Dutch colonists Kameel-dorn, because the giraffe, which the Dutch persist in calling a kameel or camel, is fond of grazing on the leaves. This is a most appropriate tree for the purpose, as the wood is extremely hard and tough, and the branches are therefore able to bear the great weight of the nests. This tree is used in Southern Africa for many purposes wherein hardness and endurance are required, such as the axle-trees of the wooden waggons, which have to withstand such rough usage, the upright timbers of houses, and the handles of tools, especially those which are intended for agricultural purposes.

The birds then hang the Booschmannie grass over a suitable branch, and by means of weaving and plaiting it, they form a roof of some little size. Under this roof are placed a quantity of nests, increasing in number with each successive brood. The nests are set closely together, so that at last they look like a mass of grass pierced with numerous holes, and it is really wonderful that the birds should be able to find their way to their own particular homes. To human eyes, the nests are as much alike as the houses in a modern street, before the blinds, the flowers, and other additions have communicated an individuality to each dwelling; but, notwithstanding this similarity, the inmates glide in and out without any hesitation.

Although the same nest-mass is occupied for several successive seasons, the birds refuse to build in the same nests a second time, preferring to make a fresh domicile for each new brood. In consequence of this custom, when the birds have entirely filled the roofs with their nests, they do not desert it, but enlarge the roof, and build a second row of nests, just like the combs of a wasp's or hornet's habitation.

Layer after layer is thus added, until the mass becomes of so enormous a size that travellers have mistaken these nests for the houses of human beings, and been grievously disappointed when they came near enough to detect their real character. There is a story of a Hottentot and a lion, which will give an idea of the dimensions of these nests. A Hottentot, who was engaged in some task, was suddenly surprised by a lion, and instinctively made for the nearest tree, which happened to be a kameel-dorn. Up the tree he sprang, and finding one of the branches occupied by the nest of the Sociable Weaver Bird, he took refuge behind the grassy mass, and was thus concealed from the pursuer.

The lion, in the meantime, arrived at the foot of the tree, but could not see his intended prey. The unlucky Hottentot, however, peeped over the nest in order to see whether the coast was clear, and was spied by the lion, who made a dash at the tree. The man shrank back behind the nest, but his imprudent movement brought its own punishment.

Knowing that the ascent of the tree was impossible, and at the same time unwilling to leave its prey, the lion sat down at the foot of the tree, and kept watch upon the man. Hour after hour the lion mounted guard over its prisoner, until thirst overpowered hunger, and the animal was forced reluctantly to quit its post and seek for water.

The man then scrambled down the tree, and made the best of his way homewards, little the worse for his imprisonment except the fright, and a skin scorched by long exposure to the sun. The artist has introduced this little episode into the illustration, because it enables the reader to judge of the enormous size of the nest.

Season after season the Weaver Birds continue to add their nests, until at last the branch is unable to endure the weight, and comes crashing to the ground. This accident does not often occur during the breeding months, but mostly takes place during the rainy season, the dried grass absorbing so much moisture, that the weight becomes too great for the branch to bear.

The nest group which is shown in the illustration is of medium size, as can be ascertained by its shape. In its early state, the nest-mass is comparatively long and narrow, spreading out by degrees as the number of nests increases, so that at last it is as wide and as shallow as an extended umbrella. The dimensions of some of these structures may be gathered from the fact, that Le Vaillant counted in one unfinished edifice, beside the deserted nests of previous seasons, no less than three hundred and twenty nests, each of which was occupied by a pair of birds engaged in bringing up a brood of young, four or five in number.

Those who are acquainted with Borneo and the customs of its inhabitants, cannot fail to perceive the analogy between these social nests of the Weaver Bird and the "long houses" of the Dyaks, each of which houses is in fact one entire village, sheltering a whole community under a single roof.

The Weaver Birds have but few enemies. First, there are the snakes, which are such determined robbers of nests, swallowing both eggs and young; and then there are the

monkeys, which are capable of sad depredations whenever they can find an opportunity. Monkeys are extremely fond of eggs, and there is scarcely a better bribe to a monkey, ape, or baboon, than a fresh raw egg. The bird which laid it is almost as great a dainty, and a monkey seems to be in the height of enjoyment if a newly-killed bird be put into its paws. It always begins by eating the brain, and then tears the carcass to pieces with great deliberation. A mouse is quite as much appreciated as a bird, provided that it has been recently killed, and that the blood has not congealed.

However, the structure of the nest forms an insurmountable barrier to the snake, and the monkey can only reach a few of the cells which are near the edge. The worst enemies are certain little parrakeets, which are delighted to be able to procure nests without the trouble of building them, and which are apt to take possession of the cells and oust the rightful owners.

CHAPTER III.

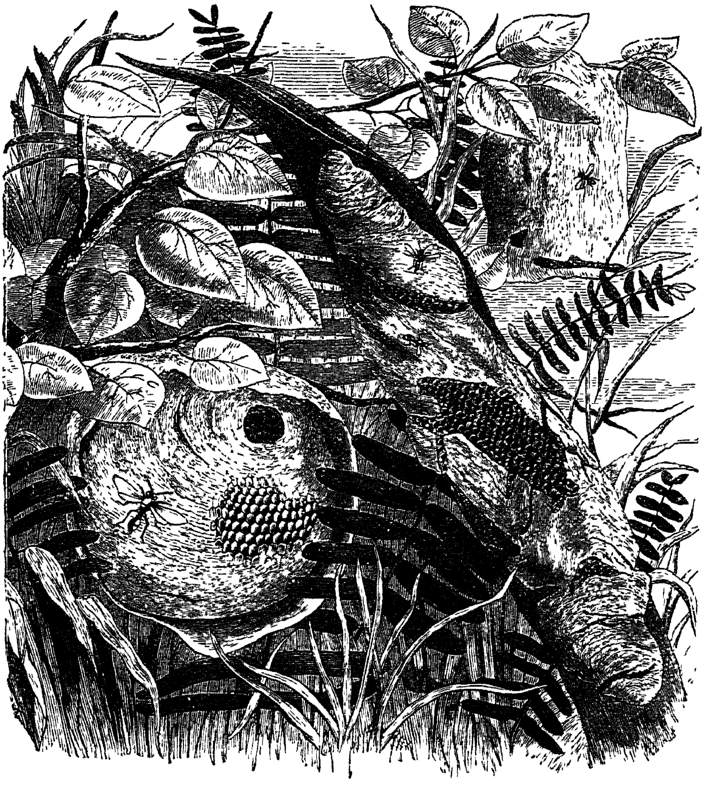
SOCIAL INSECTS.

Arrangement of groups—Nests of POLYBIA—Curious method of enlargement—Structure of the nests—How concealed—Various modes of attachment —A curious specimen—The HIVE BEE and its claims to notice—General history of the hive—Form of the cells—The royal cell—Its structure and use—Uses of the ordinary cells—Structure of the Bee-cell—Economy of space—How produced—Theories of different mathematicians—Measurement of angles—A logarithmic table corrected by the Bee-cell—The "lozenge" a key to the cell—How to form it—Beautiful mathematic proportions of the lozenge—Method of making the cell or a model—Conjectured analogy between the cell and certain crystals—Effect of the cell upon honey—The HORNET and its nest—Its favourite localities—Difficulties of taking a Hornet's nest —Habits of the insect—Mr. Stone's method of taking the nest—The SYNŒCA and its habitation—Beautiful nests in the British Museum —Description of the insect—Nest of the EUCHEIRA—Its external form—Curious discovery in dissection—A suspended colony—Conjectures respecting the structure—Nest from the Oxford Museum—Remarkable form of its doors, and material of which it is made—The SMALL ERMINE MOTH and its ravages—Its large social habitation—General habits of the larva—Why the sparrow does not eat them—The GOLD-TAILED MOTH and its beautiful social nest—Description of a specimen from Wiltshire—Illustration of the theory of heat—The BROWN-TAILED MOTH and its nest—Social habitations of the PEACH and SMALL TORTOISESHELL BUTTERFLIES.

AFTER the Social Birds come the SOCIAL INSECTS, to which the following chapter is dedicated.

Just as the hymenoptera are chief among the pensiles and the builders, so are they chief among the Social Insects, and the species which may be placed in this group are so numerous, that it will only be possible to make a selection of a few, which seem more interesting than the others.

In the British Museum there are some very remarkable nests made by hymenopterous insects belonging to the genus *Polybia*, several of which are drawn in the accompanying illustration. As it was desirable to include more than



POLYBIA.

one specimen, the figures are necessarily much reduced in size. Neither the nests nor the insects, however, are of large dimensions, and the former are so sombre in colour,

as well as small in size, that they would not of themselves attract any attention. Their nests, however, are extremely interesting, as may be seen from the examples which are figured in the illustration.

On the left hand may be seen a nearly spherical nest, which is evidently hollow, and has cells both on the outside and within the cover. These cells are not placed vertically, with their mouths downward, like those of the wasp and hornet, nor horizontally like those of the bee, but are set with their mouths radiating from the centre of the nest. Moreover, there is another curious circumstance connected with the nest. If it were to be opened, it would be seen to be composed of several concentric layers, very much like those ivory puzzle-balls which the Chinese make so beautifully.

The method by which the nest is formed is very simple, though not one that is usually seen among the hymenoptera. The layers of combs are made like hollow spheres, the mouths of the cells being outwards, and as soon as a layer is completed, the insects protect it from the weather by a cover of the same material as is used for the construction of the cells. When they require to make a fresh layer of cells, they do not enlarge the cover, as is the case with the wasp and hornet, but place the new cells upon the surface of the cover, and make a fresh cover as soon as the comb is completed. Thus the nest increases by the addition of concentric layers, composed alternately of comb and cover.

In the nest which is in the British Museum, the insects have commenced several patches of comb on the outside of the cover, and one such patch is shown in the illustration.

On the right of the globular nest is another curious structure, also made by insects of the same genus, and having a kind of similarity in its aspect. This nest, however, is very much longer in proportion to its width, and

being fixed throughout its length to a leaf, is not so plainly visible as the last mentioned specimen. Indeed, when the leaf has withered, as is the case with the object from which the drawing was made, the dull brown of the nest coincides so completely with the colour of the faded leaf, that many persons would overlook it unless their attention were specially drawn towards it.

On the extreme right of the illustration, and in the upper corner, is seen a nest which is also the work of insects belonging to the genus Polybia, and it is pendent from a bough, like the habitation of the Chartergus and other pensile hymenoptera.

In the same collection there are many more specimens of social nests formed by insects belonging to this genus, two cases being quite filled with them. One is attached to the bark of a tree, and resembles it so closely that it seems to be made of the same substance, this similarity of aspect being evidently intended as a preservative against the attacks of birds and other insect-loving creatures, which would break up the nest, and eat the immature and tender grubs. Most of the nests are fixed to leaves, and are different forms, according to the species which made them. They are mostly fixed to the under sides of the leaf, so that the weight causes the leaf to bend and to form a natural roof above them. The shape of the nest seems to depend much on the character of the plant to which it is fixed. Those that are fastened to reeds are long and slender, and generally much narrower than the sword-shaped leaf on which they rest. Others, which are fastened to short and broad leaves, adapt themselves so closely to the shape of the leaf, that, if removed, they would enable any one to conjecture the form of the leaf upon which they had been fixed.

One such nest is very remarkable. In general form it

bears a singular resemblance to the nest of the fairy martin, though its materials are entirely different. The nest is flask-shaped, and its base is fastened to a leaf, which it almost covers. The body of the nest is oval, and the entrance, which is small, is placed at the end of a well-marked neck. The shell of the nest is extremely thin, not in the least like the loose, papery structure of an ordinary wasp-nest, nor the pasteboard-like material which defends the nest of the Chartergus. It is rather fragile, and in thickness is almost double that of the paper on which this account is printed.

The name of the species which builds this curious nest is *Polybia sedula*, and the specimen was brought from Brazil.

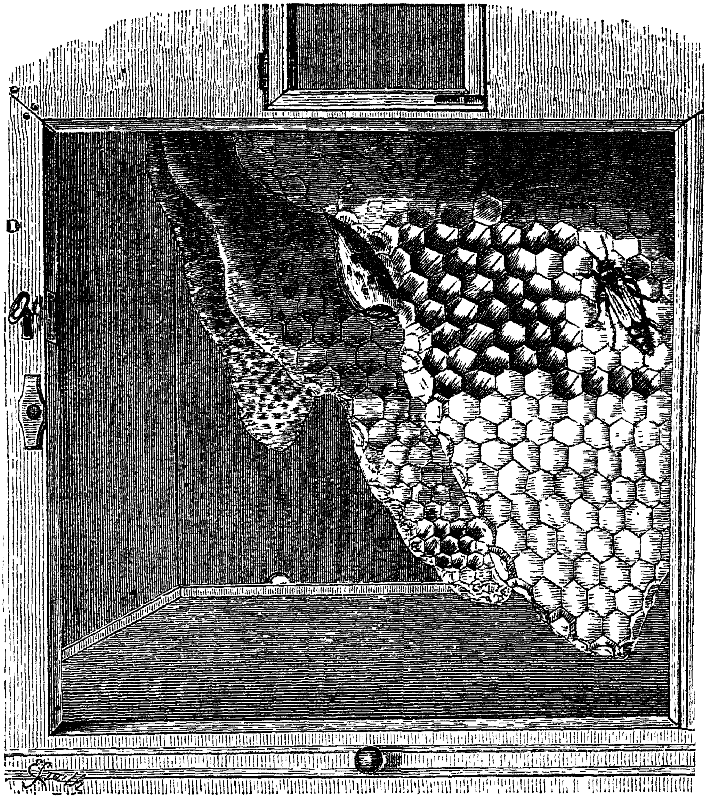
For many reasons the HIVE BEE has been reckoned among the Social Insects.

The Bee has always been one of the most interesting insects to mankind, on account of the direct benefit which it confers upon the human race. There are many other insects which are in reality quite as useful to us, and indeed are indispensable, but which we neglect because we are ignorant of their labours. The Bee, however, furnishes two powerful and tangible arguments in its favour—namely, honey and wax—and is sure, therefore, to enlist our sympathies in its behalf.

Independently, however, of these claims to our notice, if the Bee never made an ounce of honey—if the wax were as useless to us as wasp-comb—if the insect were a mere stinging creature, with a tetchy temper, it would still deserve our admiration, on account of the wonderful manner in which it constructs its social home, and the method by which that home is regulated.

The accompanying illustration shows the lower part of the interior of a hive, which is supposed to be viewed through a plate of glass set in the back. When the hive

is in full operation, the combs are so crowded with Bees that their structure can hardly be seen; but in the illustration the Bees are supposed to have gone away, with the exception of one individual.



BEE-HIVE.

I need not in this place repeat the well-known facts respecting the constitution of the Bees, nor describe the duties of the Queen, Drone, and Worker Bees. Suffice it to say, that the former is the mother as well as the queen of the

hive; that the workers are undeveloped females, which are properly called neuters; and that the drones are males, which do no work, and have no stings.

In the illustration, the Queen Bee is seen walking over the combs, and in this position she exhibits the peculiarities of form which distinguish her from her subjects, and which enable an experienced eye to detect her at once amid a crowd of workers. In the Queen Bee, the abdomen is long in proportion to its width, and the wings slightly cross each other when closed; the latter being a very conspicuous badge of sovereignty. The drones are easily distinguished by their generally larger size, their larger eyes, and the wide, blunt, and rounded abdomen.

The lower part of the comb, in the foreground, is formed of cells which are closed at their mouth, and which do not show the hexagonal shape as well as those which are yet empty. Some of the empty cells are shown above, and the Queen Bee is represented as making her way towards them.

There are three kinds of cell in a hive; namely, the worker-cell, the drone-cell, and the royal-cell. Of these, the two former are hexagonal, but can easily be distinguished by the greater size of the drone-cell; while the royal-cell is totally unlike the nursery of a subject, whether drone or worker, and is almost always placed on the edge of a comb. One of these cells is shown in the illustration, and may be seen on the edge of the comb in the foreground. It is very much larger than an ordinary cell, and is built with a lavish expenditure of wax that affords a curious contrast with the rigid economy observed in the structure of the other cells. The difference of size between the worker and drone-cells is shown in the central comb, where the worker-cells are seen below, and the drone-cells above.

The little grub which is placed in the royal cell is not fed with the same food which is supplied to the other Bees,

but lives upon an entirely different diet, and which is, apparently, of a more stimulating character; and it is now well known, that if a young grub which has been hatched in one of the worker-cells be removed into the royal-cell, and supplied with royal food, it becomes developed into a queen, and, in time, is qualified to rule and populate a hive. This remarkable provision of nature is intended to meet a difficulty, which sometimes occurs, when the reigning queen dies, and there is no royal larva in the cell.

Although the primary object of the Bee-cell is to serve as a storehouse and a nursery, it also is made to answer other purposes. When the Bee seeks repose, it almost invariably creeps into a cell, and buries itself deeply therein, the whole head, thorax, and part of the abdomen being hidden. If a hive be examined in the winter-time, every cell that happens to be empty will be tenanted by a Bee; and when the poor insects are put to death by the absurd and cruel plan of smothering them with the fumes of burning sulphur, they will be found to have vainly sought escape from the suffocating vapour by forcing themselves into the recesses of the empty cells.

As a general fact, the Bees place the honey in the coolest part of the hive, and the young brood in the warmest; so that Bee-keepers are enabled to procure honeycomb of wonderful purity by affixing glass or wooden caps to their hives. These caps are necessarily cooler than the body of the hive, and therein the Bees will store large quantities of honey.

The chief point which distinguishes the comb of the Hive Bee from that of other insects, is the manner in which the cells are arranged in a double series. The combs of the wasp or the hornet are single, and are arranged horizontally, so that their cells are vertical, with the mouths downwards and the bases upwards, the united bases forming a floor on

which the nurse wasps can walk while feeding the young enclosed in the row of cells immediately above them.

Such, however, is not the case with the Hive Bee. As every one knows who has seen a Bee-comb, the cells are laid nearly horizontally, and in a double series, just as if a couple of thimbles were laid on the table with the points touching each other and their mouths pointing in opposite directions. Increase the number of thimbles, and there will be a tolerable imitation of a Bee-comb.

There is another point which must now be examined. If the bases of the cells were to be rounded like those of the thimbles, it is clear that they would have but little adhesion to each other, and that a large amount of space would be wasted. The simplest plan of obviating these defects is evidently to square off the rounded bases, and to fill up the ends of each cell with a hexagonal flat plate, which is actually done by the wasp. If, however, we look at a piece of Bee-comb, we shall find that no such arrangement is employed, but that the bottom of each cell is formed into a kind of three-sided cup. Now, if we break away the walls of the cell, so as only to leave the bases, we shall see that each cup consists of three lozenge-shaped plates of wax, all the lozenges being exactly alike.

These lozenge-shaped plates contain the key to the Bee-cell, and their properties will therefore be explained at length. Before doing so, I must acknowledge my thanks to the Rev. Walter Mitchell, Vicar and Hospitaller of St. Bartholomew's Hospital, who has long exercised his well-known mathematical powers on this subject, and has kindly supplied me with the outline of the present history.

If a single cell be isolated, it will be seen that the sides rise from the outer edges of the three lozenges above-mentioned, so that there are, of course, six sides, the transverse section of which gives a perfect hexagon. Many years ago

Maraldi, being struck with the fact that the lozenge-shaped plates always had the same angles, took the trouble to measure them, and found that in each lozenge the large angles measured 109° 28′, and the smaller 70° 32′, the

FIG. 1

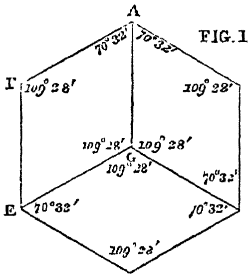


FIG. 5

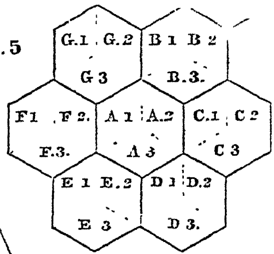


FIG. 6.

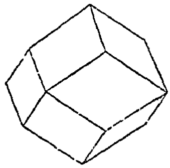


FIG 3.

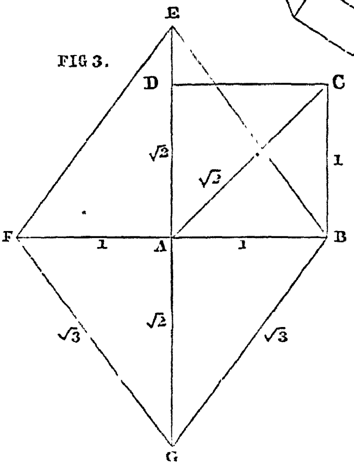
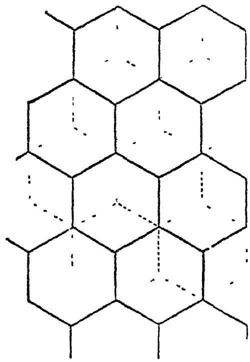


FIG. 2.



two together making 180°, the equivalent of two right angles. He also noted the fact that the apex of the three-sided cup was formed by the union of three of the greater angles. The three united lozenges are seen at fig. 1.

Some time afterwards, Reaumur, thinking that this re-

E

markable uniformity of angle might have some connection with the wonderful economy of space which is observable in the Bee-comb, hit upon a very ingenious plan. Without mentioning his reasons for the question, he asked Kœnig, the mathematician, to make the following calculation. Given a hexagonal vessel terminated by three lozenge-shaped plates; what are the angles which would give the greatest amount of space with the least amount of material?

Kœnig made his calculations, and found that the angles were 109° 26′ and 70° 34′, almost precisely agreeing with the measurements of Maraldi. The reader is requested to remember these angles. Reaumur, on receiving the answer, concluded that the Bee had very nearly solved the difficult mathematical problem, the difference between the measurement and the calculation being so small as to be practically negatived in the actual construction of so small an object as the Bee-cell.

Mathematicians were naturally delighted with the result of the investigation, for it showed how beautifully practical science could be aided by theoretical knowledge, and the construction of the Bee-cell became a famous problem in the economy of nature. In comparison with the honey which the cell is intended to contain, the wax is a rare and costly substance, secreted in very small quantities, and requiring much time for its production; it is therefore essential that the quantity of wax employed in making the comb should be as little, and that of the honey contained in it as great, as possible.

For a long time these statements remained uncontroverted. Any one with the proper instruments could measure the angles for himself, and the calculations of a mathematician like Kœnig would hardly be questioned. However, Maclaurin, the well-known Scotch mathematician, was not satisfied. The two results very nearly

tallied with each other, but not quite, and he felt that in a mathematical question precision was a necessity. So he tried the whole question himself, and found Maraldi's measurements correct, namely, 109° 28′ and 70° 32′.

He then set to work at the problem which was worked out by Kœnig, and found that the true theoretical angles were 109° 28′ and 70° 32′, precisely corresponding with the actual measurement of the Bee-cell.

Another question now arose. How did this discrepancy occur? How could so excellent a mathematician as Kœnig make so grave a mistake? On investigation, it was found that no blame attached to Kœnig, but that the error lay in the book of logarithms which he used. Thus, a mistake in a mathematical work was accidentally discovered by measuring the angles of a Bee-cell—*a mistake sufficiently great to have caused the loss of a ship whose captain happened to use a copy of the same logarithmic tables for calculating his longitude.*

Now, let us see how this beautiful lozenge is made. There is not the least difficulty in drawing it. Make any square, ABCD (fig. 3), and draw the diagonal AC.

Produce BA towards F and AD, both ways to any distance.

Make AE and AG equal to AC, and make AF equal to AB. Join the points EFGB, and you have the required figure.

Now comes a beautiful point. If we take AB as 1, being one side of the square on which the lozenge is founded, AE and AG will be equal to $\sqrt{2}$, and EF, FG, GB, and BE, will be equal to $\sqrt{3}$, as can be seen at a glance by any one who has advanced as far as the 47th proposition of the first book of Euclid.

Perhaps some of my readers may say that all these figures may be very true, but that they do not show how the cell is formed. If the reader will refer to fig. 4, he will see how the theory may be reduced to practice. After

he has drawn the lozenge-shaped figure which has just been described, let him draw upon cardboard nine of them, as is shown in the illustration (fig. 4). Then let him cut out the figure, and draw his penknife half through the cardboard at all the lines of junction. He will then find that the cardboard will fold into an exact model of a Bee-cell, the three lozenges which project from the sides forming the base, and the others the sides. This cell will, of course, have very

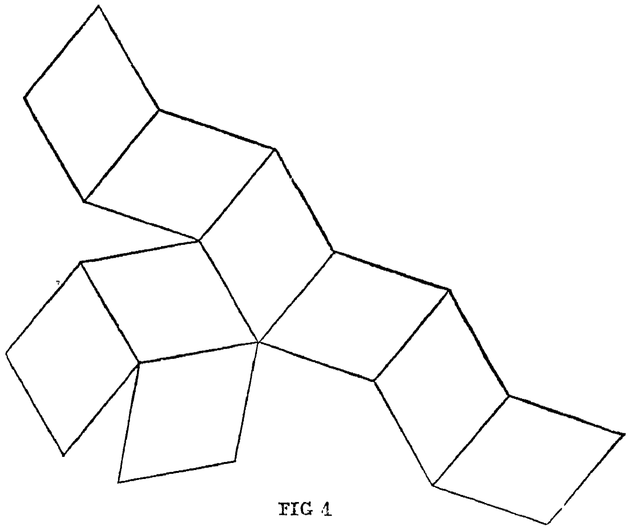


FIG 4

short sides; but by the simple expedient of widening the lozenges, which form the sides, without altering the angles, the imitation cell can be made of any desired length.

The best way of showing this beautiful structure is to make two models, one to lie flat or be folded and opened at discretion, and the other formed into a cell, and the angles written upon the cardboard. A little gummed paper will hold the sides together, so that the model can be handled without breaking. A very amusing puzzle may be formed

by cutting out the nine lozenge-shaped pieces of card-board, and by requesting that they be so put together as to form the model of a Bee-cell.

We have not yet exhausted the wonders of the Bee-comb.

If we take a piece of comb from which all the cells have been removed, and hold it up to the light, we shall see that the cells are not placed opposite each other, but that the three lozenges which form the base of one cell form part of the base of three other cells, as is seen in fig. 2. Thus a still further economy of material is attained, while the strength is enormously increased, each of the edges formed by the junction of two lozenges making a buttress which performs precisely the same office as the buttresses of architecture.

The same principle is observable throughout the cell, which even at its edges is supported by three cells, and gives partial support to three others. As the walls of the cells are extremely thin, the Bee always strengthens their mouths by a thick edging of harder wax than that with which the cell itself is made. The engineer who plans girders, boilers, and other objects of a similar character, acts in precisely the same manner, and strengthens the comparatively thin and yielding plates by flanges or angle-irons.

Many inquirers have asked themselves how the Bee constructs the comb, and on what principle it proceeds. To this question there have been several answers, none of which appear to be satisfactory. One ingenious entomologist remarked, that when the Bee placed the claws of its fore-feet against each other, the limbs embraced a hexagonal space, of which the thorax formed one side. Another, a very popular solution of the question, is that which may be called the "sculpture" theory.

The Bee that commences the task is supposed to work a lump of wax on the stick or bar which supports a comb,

and then to excavate a circular hole on one side, the interior of the hole being shaped like a concave lens. Round this hole or basin the Bee then excavates six other holes of equal diameter, so that their edges nearly touch each other. It then cuts away the wax from each basin until the material is reduced to the requisite thinness, and thus obtains the hexagonal cell. In the meantime, another Bee is working in the same manner on the opposite side of the wax, taking care, however, to make the centre of its first basin correspond with the union of three basins on the opposite side. A similar system of sculpturing is carried on, so that at last a series of hexagonal basins is formed, from which rise the walls of the future cells.

There is an amount of plausibility about this theory which is very attractive. It must, however, be remembered that the Bee is still supposed to execute problems which are as difficult as that which they are presumed to explain.

In the first place, the Bee must strike perfect circles from centres the distance of which from each other must be accurately adjusted. Again, these centres must be so placed that the centre of the circle sculptured on one side of the comb must be equi-distant from the centres of the three adjacent circles on the other side—a problem of no easy accomplishment, even with the aid of rule and compass. Then, if the circles be not perfect, or their centres wrongly placed, or the hollow of one cut deeper than that of another, or the hemispherical form of the hollow not precisely just,

assume the hexagonal form by equal pressure in all directions. Every one knows that cylinders made of a yielding substance always become hexagonal if pressed together, and a similar process was supposed to cause the hexagonal shape of the Bee-cell.

There is another theory, which I believe to be entirely original, which is suggested by the well-known mathematician and crystallographer above-mentioned. Mr. Mitchell writes to me as follows: "It may not be out of place to remark that the Bee-cell forms a mould, as it were, of the natural form of a crystal. There is in nature a great variety of crystals, hexagonal prisms terminated by three planes, like the Bee-cell. These have many different angles. But there is one form, called the rhombic dodecahedron (see fig. 6), very frequently found in natural crystals of the garnet, which has precisely the same angles as the Bee-cell.

"Certain crystals split naturally into planes precisely like the lozenges which have already been described in giving the key to the structure of the Bee-cell. May it not, therefore, be possible that wax, which is a crystallisable substance, cleaves in this particular direction, and does the Bee use this property in forming its cell? Though this vague conjecture should prove to be true, we shall not less admire the marvellous instinct which combines this fact with the structure of the cell."

It would, of course, be easy to fill many pages with the account of the Hive Bee and its habits; but as this work is restricted to the habitations of animals, we can only look upon the Bee as a maker of social habitations. It will, however, be necessary to mention the material of which the comb is made.

The other hymenoptera obtain their materials from external sources. The hornet and wasp have recourse to

trees and branches, and bear home in their mouths the bundles of woody fibres which they have gnawed away. The upholsterer and leaf-cutter Bees are indebted to the petals and leaves of various plants, and various wood-boring insects make their homes of the woody particles which they have nibbled away. The Bee, however, obtains her wax in a very different manner.

If the body of a worker Bee be carefully examined, on the under sides of the abdomen will be seen six little flaps, not unlike pockets, the covers of which can be easily raised with a pin or needle. Under these flaps is secreted the wax, which is produced in tiny scales or plates, and may be seen projecting from the flaps like little semilunar white lines. Plenty of food, quiet, and warmth are necessary for the production of wax, and as it is secreted very slowly, it is so valuable that the greatest economy is needed in its use. It is, indeed, a wonderful substance; soft enough when warm to be kneaded and to be spread like mortar, and hard enough when cold to bear the weight of brood and honey. Moreover, it is of a texture so close that the honey cannot soak through the delicate walls of the cells, as would soon be the case if the comb were made of woody fibre, like that of the hornet or wasp.

Indeed, it is a most remarkable fact that the Bee should be able to produce not only the honey, but the material with which is formed the treasury wherein the honey is stored. Honey itself is again scarcely less remarkable than wax. The Bee goes to certain flowers, inserts its hair-clad proboscis into their recesses, sweeps out the sweet juice, passes the laden proboscis through its jaws, scrapes off the liquid and swallows it. The juice then passes into a little receptacle just within the abdomen called the "honey-bag," which is apparently composed of an exceedingly delicate membrane, and seems to discharge no other office

than that of a vessel in which the juice can be kept while the Bee is at work.

As soon as the honey-bag is filled, the Bee flies back to the hive and disgorges the juice into one of the cells. But, during that short sojourn in the insect, the juice has undergone a change, and been converted into honey, a substance which is quite unlike that from which it was formed, and which has an odour and flavour peculiarly its own. How this change is wrought is at present unknown, for the little bag in which the transformation is made is composed of a membrane that seems incapable of exerting any influence upon the substance contained within it.

All food that is eaten by the Bee passes through the honey-bag, which is closely analogous to the crop of a bird, and it would seem that the honey ought rather to pass into the stomach than be disgorged at the will of the insect. However, it is well known that many birds feed their young by disgorging food, and the Bee is enabled to perform the same operation by means of a little valve which leads from the honey-bag into the stomach, and is plainly perceptible even with the unassisted eye. Under ordinary circumstances, the valve just allows the food to pass gently and gradually into the stomach; but the violent effort, which is made in ejecting the food, closes the valve, and only allows the honey to flow upwards through the mouth.

The office of the worker and drone cells is two-fold—first, to act as nurseries for the insects while passing through their preliminary stages, and next to serve as repositories for food, whether liquid or solid. The egg of the Queen-Bee is placed nearly at the bottom of the cell, exactly on the angle where the points of the lozenges meet. It is soon hatched into a little white grub, which is assiduously fed by the nurses, and grows with wonderful rapidity. As soon as it has eaten its last larval meal, it spins a silken cover

over the cell, and remains there until it has become a perfect insect. It then bites its way out, and after a day or so devoted to hardening and strengthening its limbs, it leaves the hive and joins in the labours of the community.

No sooner is the Bee fairly out of its waxen nursery, than the workers clear out the cell, and prepare it for the reception of honey. As soon as the cell is filled, the Bees close up the entrance with a waxen door, which is air-tight, and serves to preserve the honey in proper condition. Those who wish to eat honey in its pure state should always purchase it in the comb. If it be stored in pots, however well they may be sealed, it always crystallises, and in that state is injurious to digestion. Moreover, it is so extensively adulterated, that a pot of really pure honey is not readily obtained.

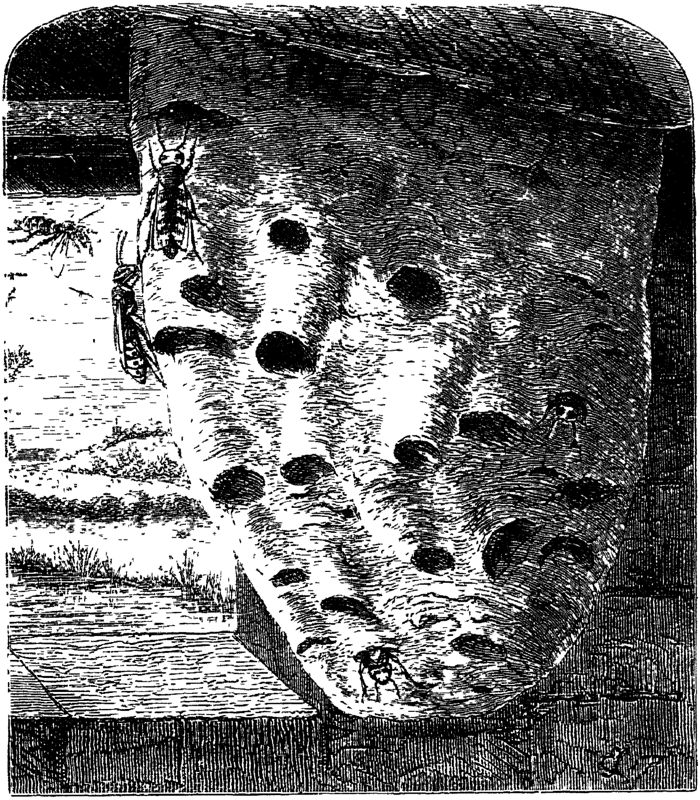
Besides the honey, "Bee-bread" is placed in the cells. This is a compound of honey and the pollen of flowers, and is chiefly used as food for the young grubs. We may often see the Bees hastening home with a load of yellow pollen on each of the hinder pair of legs, and this pollen is destined to be made into Bee-bread.

Such, then, is a brief outline of the wonderful social habitation which is made by the Hive Bee.

We now come to an insect which is as well known by name as the Bee, though not so familiar to our eyes. This is the common HORNET, which is tolerably plentiful in many parts of England, but seems to be almost absent from others.

The nest of the Hornet is much like that of the wasp, except that it is proportionately larger, and is almost invariably built in hollow trees, deserted outhouses, and places of a similar description. Whenever the Hornet takes up its residence in an inhabited house, as is sometimes the

case, the inmates are sure to be in arms against the insect, and with good reason. The Hornet is much larger than the wasp, and its sting is proportionately venomous. It is popularly said that three Hornets can kill a man;



HORNET.

and although in such a case the sufferer must previously have been in bad health, the poisonous properties of the Hornet are sufficiently virulent to render such a saying popular.

Moreover, the Hornet is an irascible insect, and given to assault those whom it fancies are approaching its nest with evil intentions. It is not pleasant to be chased by wasps, but to be chased by Hornets is still less agreeable, as I can personally testify. They are so persevering in their attacks that they will follow a man for a wonderfully long distance, and if they be struck away over and over again, they will return to the charge as soon as they recover from the shock. There is a deep ominous menace in their hum, which speaks volumes to those who have some acquaintance with the language of insects; and no one who has once been chased by these insects will willingly run the same risk again.

Mr. S. Stone, tells me that he has been successful in breeding Hornets as well as wasps, and forcing them to build nests much more beautiful than they would have made if they had been at liberty.

One nest, when of moderate size, was removed from the head of a tree, and placed in a large glazed box. Within the box the Hornets continued their labours, and a most beautiful nest was produced, symmetrical in shape, and variegated with wonderfully rich colours. "Such a nest as that," writes Mr. Stone, "is not produced by Hornets in a general way. They do not trouble themselves to form much of a covering, especially when a small cavity in the head of a tree is selected, which is often the case. The walls of the chamber they consider a sufficient protection for the combs.

"If you expect them to form a substantial covering, the combs must be so placed as to have ample space around them, and if you expect them to fabricate a covering of great beauty, you must select the richest coloured woods, and such as form the most striking contrasts, and place them so that the insects shall be

induced, nay, almost compelled, to use them in the construction of their nest. This is exactly what I did with reference to the nest in question."

Knowing from experience the difficulty of assaulting a Hornet's nest, I asked Mr. Stone how he performed the task, and was told that his chief reliance was placed on chloroform. Approaching very cautiously to the nest, he twists some cotton wool round the end of a stick, soaks it in chloroform, and pushes it into the aperture. A mighty buzzing immediately arises, but is soon silenced by the chloroform, and as soon as this result has happened, mallet, chisel, and saw are at work, until the renewed buzzing tells that the warlike insects are recovering their senses, and will soon be able to use their formidable weapons. The chloroform is then re-applied until they are quieted, and the tools are again taken up.

The extrication of a nest from a hollow tree is necessarily a long and tedious process, on account of the frequent interruptions. Even if the insects did not interfere with the work, the labour of cutting a nest out of a tree is much harder than could be imagined by those who have not tried it.

Moreover, the habits of Hornets are not quite like those of the wasps. At night, all the wasps retire into their nest, and in the dead of night the nest may be approached with perfect safety, the last stragglers having come home. Hornets are apt to continue their work through the greater part of the night, and if the moon be up, they are nearly sure to do so. Therefore, the nest-hunters are obliged to detail one of their party as a sentinel, whose sole business it is to watch for the Hornets that come dropping in at intervals, laden with building materials or food, and that would at once dash at the intruders upon their domains. Fortunately, the light from the lanterns seems to blind them,

and they can be struck down as they fly to and fro in the glare.

The nest that has just been mentioned was rather deeply imbedded in the tree, and cost no less than six hours of continuous labour, the work of excavation having been begun at 8 P.M. and the nest extracted at 2 A.M. on the following morning.

In the illustration is seen a portion of a lately begun nest, much reduced in size, as may be conjectured from the dimensions of the insects that are crawling upon it. As the arrangement of the combs is identical with that of the wasp-nest, the interior is not disclosed. Another reason for showing the exterior of the nest is, that the reader might see how the Hornet forms the paper-like cover, and the manner in which the insects can enter at different parts, instead of having but a single entrance, as is the case with several hymenopterous nests which have been mentioned.

In many parts of Brazil there may be seen the social nests of certain hymenopterous insects, which are very aptly termed *Synœca*, this name being derived from two Greek words, which signify sociality.

The nests of these insects have some resemblance to those of certain Polybiæ, which have already been described. They are, however, of much greater size, and as they are rather heavy, are affixed to tolerably strong branches. One such nest, which is now in the British Museum, has been built upon a post, nearly encircling it above, and sloping off to a rounded point, nearly two feet below the highest portion. Another is fixed to a rather stout, straight, and upright branch. The nests are dark brown in colour, and as they are fixed to objects of a similar hue, are very inconspicuous. The insect which makes this nest is nearly as large as the English hornet.

The walls of the nests made by insects of this genus are very thin and fragile, not unlike those of the structure built by *Polybia sedula*. In one nest the cover is remarkably elegant, being shaped like the half of a melon cut longitudinally, and moulded into ribs which run transversely across the nest, and have a gentle and regular curve. These ribs project about a quarter of an inch, and are nearly half an inch wide, and are as round and regular as if they were produced by cords wound upon the combs.

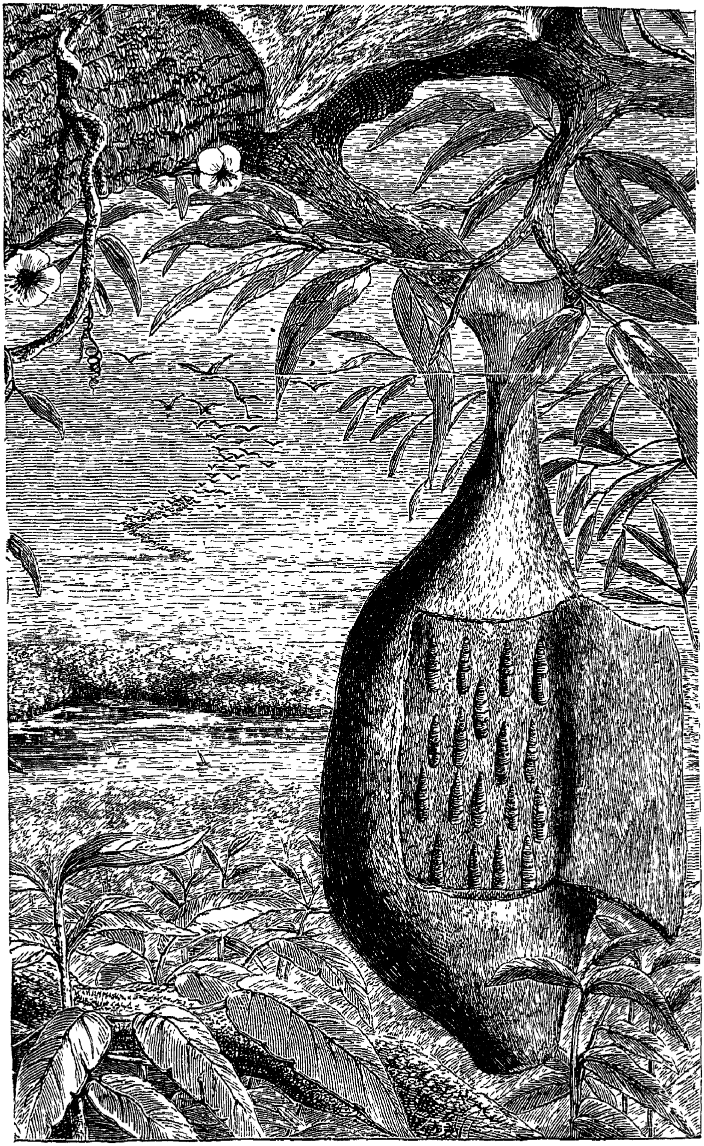
The insect which made this nest is of a deep steel-blue colour, looking nearly black in a dim light. The head is rather large, and the abdomen is rounded and small, being connected with the thorax by a footstalk of moderate length.

The two remarkable nests, which are figured in the illustrations on pages 48 and 50, come from different parts of the world, but they are similar in many respects.

The long, flask-like nest was brought from Mexico, by Owen Rees, Esq., in 1834. Even before it was opened, its structure was evidently full of interest. The colour is dull white, not unlike parchment, and the texture of the materials is nearly as hard, stiff, and close as that substance. When placed under the microscope, it is seen to be composed of a vast number of shining threads, crossing and recrossing each other in every direction, and producing a material like very thin, but stiff felt.

It was suspended to a branch, but could not swing in the wind, because a twig descended into the neck and prevented any lateral motion. At the bottom of the nest there is a small and nearly circular aperture, through which the insects are enabled to make their exit and entrance. The length of the nest is about eight inches.

So much for the exterior. On opening the nest, however,



NEST OF SOCIAL LEPIDOPTERA.

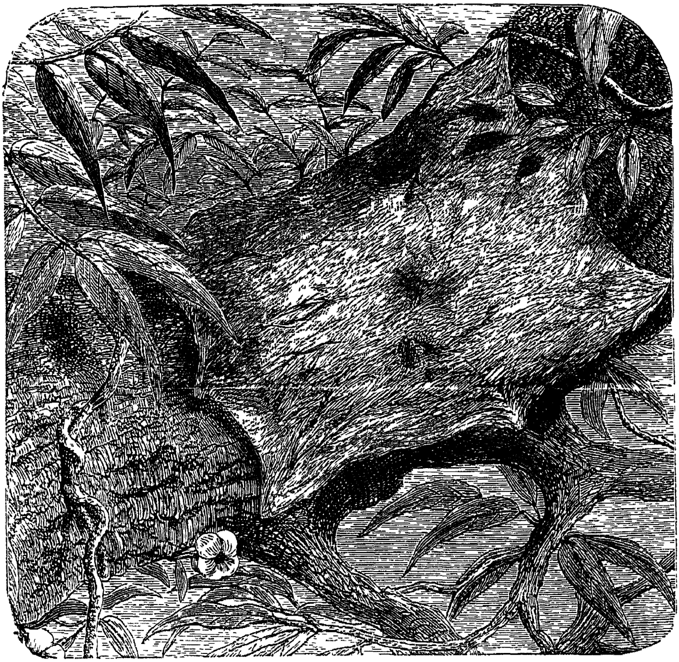
a most singular state of things was discovered. A great number of pupæ, evidently those of some butterfly, were suspended by their tails to the walls and to the twig which runs down the nest. In this nest they were about one hundred in number, and they were hung to the whole of the upper part of the nest, but without any particular order.

On seeing this nest, an entomologist naturally asks how and when the insects made it. That they did not form it of a small size and then add to its dimensions in order to suit their growth, is evident from the fact that no trace of enlargement can be perceived. It is most probable that as in the case of the processionary moth, the caterpillars spin their silken home when they are three parts grown, and in consequence have but a short time to spend in it before they pass into the quiescent pupal form.

It is evident that the insects make their escape from their pensile home as soon as they have broken out of the pupal skin, because the aperture is so small that they could not possibly pass through it when their wings were thoroughly expanded and dried. Of what form and colour these wings might be, was for a long time a mystery. Mr. Westwood, who first opened a nest, carefully dissected some of the pupæ, and by cautiously softening the withered membranes in warm water, succeeded in spreading out the wings sufficiently to learn the general form of the nervures and the shape of the "cells," as the spaces between the nervures are named.

Specimens of the perfect insect have now been obtained, and are seen to be butterflies closely resembling in shape the lovely heliconidæ, which are so plentiful in Southern America, but of very simple colours, the general hue being blackish brown diversified by a broad, but indistinctly marked, white band across the wings. Examples of the

nest have lately been sent to Vienna, but any one who wishes to see the specimen from which the sketch on p. 49 and the above description were taken, may do so by visiting the Museum at Oxford, where the perfect butterflies



NEST OF SOCIAL LEPIDOPTERA.

may also be seen. The scientific name of the butterfly is *Eucheira socialis*.

In the middle of the above illustration may be seen a curious object, that looks something like a flattened pincushion fastened to the branches. This is the nest of a social insect, and is, I believe, an unique specimen. It

was brought from Tropical Africa by Vernon Wollaston, Esq., and is so remarkable as to deserve a detailed description.

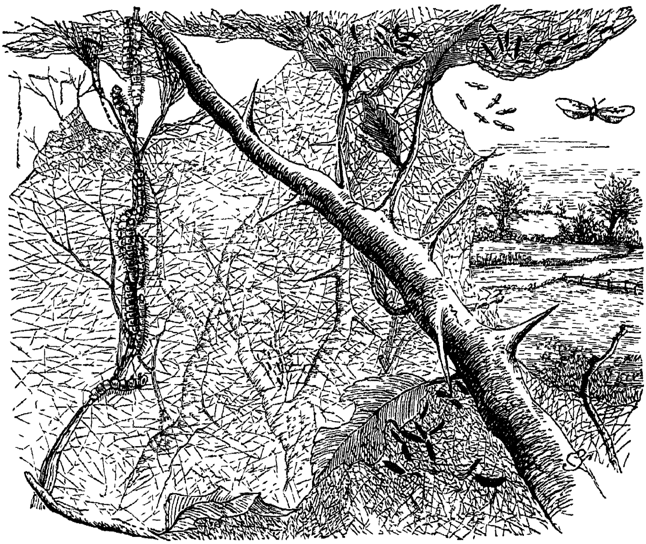
In length it measures eight inches, and in width five and a half inches, its depth being about three inches. The aspect of the exterior gives but little promise of the exceeding strength of the structure, which is as hard and elastic as the side of a silk hat, rebounding when pressed in precisely the same manner. When cut, this covering is seen to be double, the outer case being very thin, and formed of orange-brown silken threads, and the inner being made of many successive layers of dark brown silk, so that it looks very like undressed leather.

The most extraordinary part of the nest, however, is the provision which is made for the exit of the inmates. Set upon different parts of the nest are thirteen or fourteen little conical protuberances, which do not project very far from the general surface, and are quite inconspicuous. On examination, these prominences are seen to be composed of stiff silken threads, which converge to a point, precisely like those which guard the entrance of the emperor moth's cocoon, so that any inhabitant can crawl out, but no enemy can crawl in.

This nest, like the preceding, may be seen in the Museum at Oxford.

There is a very pretty, very interesting, and very destructive insect, called by entomologists the SMALL ERMINE MOTH, which is very plentiful in this country, and by gardeners is thought to be much too plentiful. It can easily be recognised by its long narrow wings, the upper pair of which are soft silvery, or satiny white, spotted with black, and the lower pair dark brown. The expanse of the spread wings is about three-quarters of an inch.

In its winged and pupal states the insect is perfectly harmless, but in its larval condition it becomes a terrible pest. Most caterpillars wage war singly on the foliage, and though they do much damage, their ravages are conducted in a desultory manner. The Small Ermines, however, band themselves together in hosts, and march like disciplined armies to the attack, invading a district



SMALL ERMINE MOTH.

and completely devastating it before they proceed to another.

They live in large tents, placed among the branches of some tree, and composed of silken threads, which are loosely crossed and recrossed in various directions. From this centre the caterpillars issue in vast numbers, each individual spinning a strong silken thread as it proceeds, which acts as a guide to the nest, just as the fabled clue

led through the intricacies of Rosamond's bower. When once these caterpillars have taken possession of a tree, they are sure to strip it of its leaves as completely as if the foliage had been plucked by hand. It is a very curious sight to watch the systematic manner in which these troublesome insects set about their work, how they send out pioneers which lead the way to new branches, either by crawling up to them or by lowering themselves to them by means of their silken life-lines, and how soon they are followed by their ever hungry companions.

Perhaps the reader may wonder why the little birds do not eat these caterpillars. When they have nearly stripped the branch, they are very conspicuous, especially as they make their way from bough to bough along their silken bridges. Indeed, a proprietor of a garden that was much damaged by this moth did once mention the immunity of the caterpillars as a proof that any tenderness to small birds was misplaced, saying that if the sparrows were half as insectivorous as I mentioned, they would long ago have eaten all the caterpillars.

Now, at the first glance, there seemed to be some reason in this remark; but a short look at one of the damaged trees explained the reason why the sparrows did not eat the caterpillars. The birds literally dared not approach the insects; for the silken threads which traversed the branches in all directions were an effectual barrier, striking against the wings and terrifying the poor birds. We all know that a few threads of fine cotton passed from bough to bough of a gooseberry-bush will deter any little bird from settling on it; and, in the same manner, the silken threads of the caterpillars deter the birds from settling on the branches. These threads are very elastic, and of marvellous strength, considering their tenuity, producing most uncomfortable sensations when

they come across the face, and being nearly as strong as the fibres spun by the common silkworm.

The caterpillar which works all this damage is rather slender, and is covered with black dots along the back.

Another well-known British insect which constructs social habitations is the GOLD-TAILED MOTH, a familiar and beautiful insect, with wings of soft downy plumage, and snowy-white in colour, and a tuft of yellow hair at the end of the tail. The perfect insect may often be seen sticking on the trunks of trees in gardens, waiting until the evening, when it will fly off to its labours.

When the moth has laid its eggs, it plucks off the beautiful yellow tuft at the end of the tail, and with it forms a roof over the pile of eggs, laying the hairs so artificially as to make a perfect thatch. When the larvæ are hatched, they retain their sociability, and spin for themselves a common domicile. This house is very remarkable. Viewed on the exterior, it is seen to be a bag-like structure of whitish silk, rather strong and tough, but very yielding.

One of these nests, which I found in Wiltshire, is now before me. It was found in a hedge, about two feet from the ground, and is rather a complicated structure. The scaffolding, so to speak, of the nest is formed by a horizontal spray of three small twigs, and it is strengthened by the long hedge-grass which crossed the spray. Seeds of different kinds are woven into the walls, so that a comparatively small portion of the silk is exposed to view.

When cut open, it shows a singularly beautiful structure within. There are several sheets of silken tissue, each becoming more delicate, and the innermost being white, shining like satin; whereas the outer covering is dull-

white, and very tough, clinging to the scissors so that a straight cut is almost impossible. Delicate walls divide the interior into several compartments, in all of which are evidences that the caterpillars must have resided for some time. The reason why the creatures make this nest is, that they are hatched towards the end of summer, and in consequence are forced to pass the winter in the larval condition, so that some warm residence is needful for them. It is well known that air is a very bad conductor of heat, and, in consequence, the successive sheets of silk which cover the nest, and which enclose layers of air between them, form a protection which is far warmer than would be obtained by a solid mass of silk measuring twice the thickness of the three walls, together with their intervening spaces.

There is an allied insect, popularly called the BROWN-TAILED MOTH, which spins a social nest that in many respects resembles that of the Gold-tailed Moth. The nest, however, is scarcely so elegant, nor is the silken web so beautifully delicate. Much, however, depends upon surrounding conditions, such as the disposition of the twig on which the nest is placed, and the presence or absence of leaves, whether those of the tree or of other plants that happen to grow in close proximity.

These nests are very firmly constructed, and the walls are solid, as is needful for insects which are obliged to pass the winter within them. There are, however, many caterpillars which live socially, and which spin a common habitation, but which leave it before the cold weather comes on, and, in consequence, do not need such thick walls. Any hedgerows where nettles are found will supply numerous examples of such nests, made by the curious caterpillars which afterwards assume the lovely and familiar forms

of the Peacock and Small Tortoise-shell Butterflies. Great black masses of these caterpillars may be seen upon the nettles, and, on examining them closely, they will be seen to reside within a common home, made of tough silken threads, very loosely spun, and forming a kind of net, with long and irregular meshes.

CHAPTER IV.

SOCIAL INSECTS—(continued).

A curious Ant from India—Locality of its nest—Description of the nest—Its material and mode of structure—A nocturnal misadventure—The DRIVER ANT of Africa—Description of the insect—Reason for its name—Its general habits—Destructive powers of the Driver Ant—How the insects devour meat and convey it home—How they kill snakes—Native legend of the Python—Their mode of march—Fatal effects of the sunbeams—An extemporised arch—Method of escaping from floods—Site of their habitation—Modes of destroying them—Living ladders and their structure—Method of crossing streams—Tenacity of life—A decapitated Ant—Mode of biting—Description of the insect—Curious nest of a Brazilian Wasp—Weight of the nest and method of attachment—Variety of Polistes nest—*Polistes aterrimus* and its singular nest—Beautiful structure of an unknown Polistes.

ALTHOUGH several species of Ants may be better classed among the burrowing insects, there are many which possess very interesting habits, and which may here take their place among the creatures which build social habitations. Among them is a curious insect inhabiting India, and discovered by Colonel Sykes, the well-known naturalist.

This insect forms its nest on the branches of trees and shrubs, and Colonel Sykes mentions that he has found their curious habitation on the branches of the Kurwund shrub, and on the Mango-tree.

The nests are more or less spherical, and are about as

large as an ordinary football. The material of which they are made is cow-dung, which is spread in flakes in a manner that reminds the observer of the outside cover of a wasp's nest. The flakes are placed upon each other like the tiles of a house, so that although the insects can creep into the nest beneath the flakes, no water can enter. On the summit of the nest is one very large flake, that acts as a general roof to the structure.

Within the nest are placed a number of cells made of the same material as the exterior, and in them may be found insects in every state of development, eggs in one, larvæ in another, and pupæ in a third. No provision seems to be laid up within the nest, so that the inhabitants must depend on their daily excursions for their food.

When Colonel Sykes brought home the first nest he discovered, he hung it to the tent-pole, preparatory to examining it in the morning. "In the night the men were awakened by repeated punctures and general irritation of the skin, but the darkness prevented them from discovering their tormentors, and they continued to toss and tumble in their beds for some hours in no very complacent state of mind. At last they got up, dressed themselves, and abandoned the tent; but the evil was rather aggravated than abated, as parts of their persons which had previously escaped had now their share of suffering. At daylight they discovered to their consternation that they were covered with minute ants, which had filled their pantaloons, penetrated the sleeves of their coats and every other part of their habiliments. On inspecting the tent, they found the interior teeming with multitudes of little angry beings, in busy progress, seeking to resent the outrage which had been committed on the community by the removal of their abode."

The insects are extremely small, barely one-fifth of an inch in length, and are reddish in colour.

Perhaps one of the most terrible of insects is that which is appropriately called the DRIVER ANT of Western Africa.

This insect is a truly remarkable creature. Although it is to be found in vast numbers, it has never been found in the winged condition, and neither the male nor the female have as yet been discovered. The workers are uniform in colour, but exceedingly variable in size. Their hue is deep brownish black, and their length varies from half an inch to one line, so that the largest workers nearly equal the common earwig, while the smallest are no larger than the familiar red ant of our gardens. In the British Museum are specimens of the workers, which form a regular gradation of size, from the largest to the smallest.

They are called Driver Ants, because they drive before them every living creature. There is not an animal that can withstand the Driver Ants. In their march, they carry destruction before them, and every beast knows instinctively that it must not cross their track. They have been known to destroy even the agile monkey, when their swarming host had once made a lodgment on its body, and when they enter a pigstye, they soon kill the imprisoned inhabitants, whose tough hides cannot protect them from the teeth of the Driver Ants. Fowls they destroy in numbers, killing in a single night all the inhabitants of the hen-roost, and having destroyed them, have a curious method of devouring them.

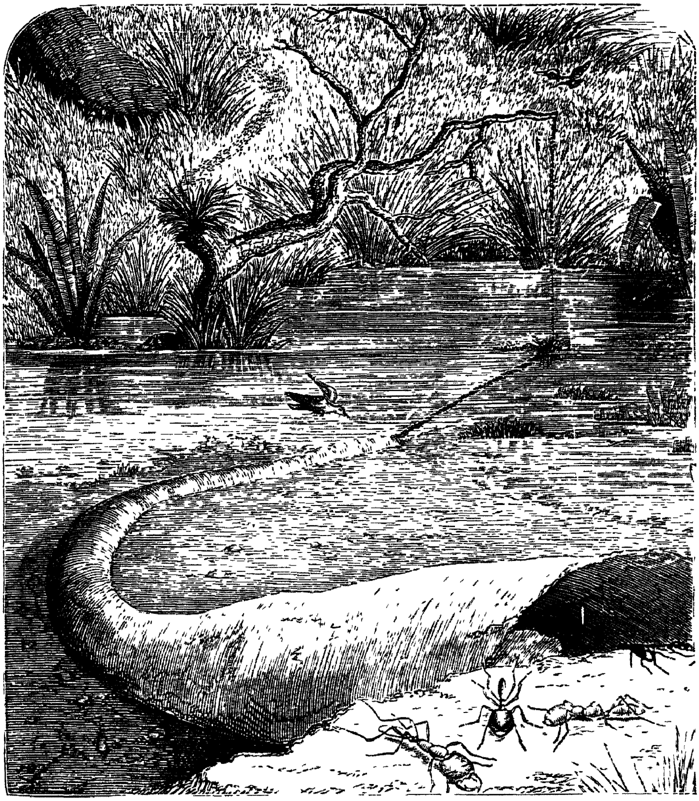
The Rev. Dr. Savage, who has experimented upon these formidable insects, killed a fowl and gave it to the Ants. At first, they did not seem to pay much attention to it, but he soon found that they were in reality making their

preparations. Large parties of the insects were detached for the purpose of preparing a road, and worked with the assiduity which seems to be a characteristic of these energetic insects. Numbers of them were employed in smoothing the road to the nest by removing every obstacle out of the way, until by degrees a tolerably level road was obtained. The Ants are possessed of strength which seems gigantic when compared with their size, carrying away sticks four or five times as large as themselves, and never failing to pounce upon any grub or insect that might happen to be lurking beneath their shelter. They always carried such burdens longitudinally, grasping them with their jaws and legs, and passing the load under the body. Some of these roads are more than two hundred yards in length.

Meanwhile, the other Ants were busy with the fowl. Beginning at the base of the beak, they contrived to pull out the feathers one by one, until they stripped it regularly backwards, working over the head, along the neck, and so on to the body. This was evidently a very hard task, as the insects did not possess sufficient strength to pull out the feathers by main force, and were consequently obliged to grub them up laboriously by the roots. The next business was to pull the bird to pieces, and at this work they were left. Unfortunately the experiment was spoiled by the natives, who stole the fowl, thinking that the Ants had eaten so many of their poultry that they were justified in retaliation. Others chose to excuse themselves by saying that they thought the fowl to be a fetish offering to the Ants, and accordingly took it away from them.

The large iguana lizards fall victims to the Driver Ants, and so do all reptiles, not excluding snakes. It seems, from the personal observations of Dr. Savage, that the

Ants commence their attack on the snake by biting its eyes, and so blinding the poor reptile, which only flounders and writhes helplessly on one spot, instead of gliding away to a distance.



DRIVER ANTS

It is said by the natives, that when the great python has crushed its prey in its terrible folds, it does not devour it at once, but makes a large circuit, at least a mile in

diameter, in order to see whether an army of Driver Ants is on the march. If so, it glides off, and abandons its prey, which will soon be devoured by the Ants; but if the ground is clear, it returns to the crushed animal, swallows it, and gives itself to repose until the process of digestion be completed. Whether this assertion be true or not, Dr. Savage cannot say; but it is here given in order to show the extreme awe in which the natives hold the Driver Ants.

So completely is the dread of them on every living creature, that on their approach whole villages are deserted, and in extreme cases the entire population is forced to take to the rivers, knowing that the insects will not enter water unless obliged to do so; although on occasions they do not hesitate to commit themselves to the waves, as will presently be seen.

The order of their marching is very curious, and is well described by Dr. Savage:—

"Their sallies are made in cloudy days, and in the night, chiefly in the latter. This is owing to the uncongenial influence of the sun, an exposure to the direct rays of which, especially when the power is increased by reflection, is almost instantaneously fatal. If they should be detained abroad till late in the morning of a sunny day by the quantity of their prey, they will construct arches over their path, of dirt agglutinated by a fluid excreted from their mouth. If their way should run under thick grass, sticks, &c., affording sufficient shelter, the arch is dispensed with; if not, so much dirt is added as is necessary to eke out the arch in connection with them. In the rainy season, or in a succession of cloudy days, the arch is seldom visible; their path, however, is very distinct, presenting a beaten appearance, and freedom from everything movable.

"They are evidently economists in time and labour; for if a crevice, fissure in the ground, passage under stones, &c., come in their way, they will adopt them as a substitute for the arch.

"In cloudy days, when on their predatory excursions, or migrating, an arch for the protection of the workers is constructed of the bodies of their largest class. Their widely-extended jaws, long slender limbs, and projecting antennæ, intertwining, form a sort of network, that seems to answer well their object. Whenever an alarm is given, the arch is instantly broken, and the ants, joining others of the same class on the outside of the line, who seem to be acting as commanders, guides, and scouts, run about in a furious manner, in pursuit of the enemy. If the alarm should prove to be without foundation, the victory won, or danger passed, the arch is quickly renewed, and the main column marches forward as before, in all the order of an intellectual military discipline."

Sometimes, as is usual in tropical countries, the rain descends like a flood, converting in a few minutes whole tracts of country into a temporary lake. The dwellings of the Driver Ant are immediately deluged, and, but for a remarkable instinct which is implanted in the insects, most of the Ants, and all the future brood, would perish. As soon as the water encroaches upon their premises, they run together and agglomerate themselves into balls, the weakest (or the "women and children," as the natives call them) being in the middle, and the large and powerful insects on the outside. These balls are much lighter than water, and consequently float on the surface, until the floods retire and the insects can resume their place on dry land.

The size of the ant-balls is various; but they are, on an average, as large as a full-sized cricket-ball. One of these

curious balls was cleverly caught in a handkerchief, put in a vessel, and sent to Mr. F. Smith, of the British Museum, who has kindly presented me with several specimens of the insect.

When a colony of these insects has been established near a house, the inhabitants naturally endeavour to destroy it. The habitation is very simple and artless, and generally consists of a mere hole in a rock or bank, in which the creatures assemble. They are very fond of usurping the sepulchres of the dead, which are usually excavated in the sides of hills, and are about eighteen inches in depth.

The natives generally try to destroy the colony by heaping dry leaves of the palm upon the dwelling, and setting fire to the heap. When this plan was tried, it was found to be very unsatisfactory; for the greater mass of the insects contrived to make their escape, and were found upon neighbouring trees, clinging in heavy bunches and long festoons, which connected one branch with another, and formed ladders over which the insects could pass. These festoons were made in a very curious manner.

First, a single Ant clung tightly to a branch, and then a second insect crawled cautiously down its suspended body, and hung to its long, outstretched limbs. Others followed in rapid succession, until they had formed a complete chain of Ants, which swung about in the wind. One of the largest workers then took its stand immediately below the chain, held firmly to the branch with its hind limbs, and dexterously caught with its fore-legs the end of the living chain as it swung past. The ladder was thus completed, and fixed ready for the transit of insects; and, in a similar way, the whole tree was covered with festoons of Ants, until it was blackened with their sable bodies.

They can even cross streams by means of these ladders.

Crawling to the end of a bough which overhangs the water, they form themselves into a living chain, and add to its length until the lowermost reaches the water. The long, widespread limbs of the insect can sustain it upon the water, especially when aided by its hold on the suspended comrade above.

Ant after Ant pushes forward, and the floating portion of the chain is thus lengthened, until the free end is swept by the stream against the opposite bank. The Ant which forms the extremity of the chain then clings to a stick, stone, or root, and grasps it so firmly, that the chain is held tightly, and the Ants can pass over their companions as over a suspension bridge. In the illustration a column of Driver Ants is shown on the march. The vanguard of the column has crossed the stream by means of the living ladder, which is seen suspended from a branch, and extended across the water. The fragile tube which they build is also shown, and a few of the larger architects are drawn of the natural size. The smaller specimens will not emerge from the tunnel.

There is a species of Ant in Ceylon which makes living bridges in precisely the same manner as the Driver Ant. In Mr. E. Sullivan's "Bungalow and the Tent" there is the following passage:—"I have seen Ants form a bridge from one stick to another. I even saw one leave his companions, who were clustered at the end of a stick, unable to reach another at a short distance, make a considerable circuit, ascend the stick they were aiming at from another direction, and by stretching out his body as far as possible, enable the pioneer of the main body to reach him, and thus complete the chain of communication, by which the rest immediately crossed. It would be difficult to prove that this was not reason."

Finding that the comparatively gradual action of fire

permitted the active insects to escape before the heat finally reached them, Dr. Savage waited until they had settled in their home, and then poured upon them a few gallons of boiling water, which was instantaneously fatal. As for cold water, they seem to care little for it; having been immersed for twelve hours, and although they were apparently dead when removed, yet they soon recovered themselves, and ran about as lively as ever. Their tenacity of life is indeed wonderful, and injuries which would immediately kill almost any creature seem to have no immediate effect upon their vigour. Another fact, illustrating their tenacity of life, may here be stated.

"The head of one of the largest class, when dissevered from the body, grasped the finger of an attendant so furiously, as to cause an immediate flow of blood. It was left in a glass tumbler from three P.M. till the next morning at eight o'clock, when the finger was again applied, and apparently as severe a wound as before inflicted. Another individual of the same class was decapitated at seven A.M., and at half-past nine next morning, twenty-six and a half hours from the time of decapitation, a piece of newspaper was held between the jaws, which it grasped and retained with considerable force.

"I then applied the small finger of my right hand, which it bit severely; indeed, so powerful was the grasp, that the point of the mandibles met beneath the cuticle. It then partly withdrew one mandible, and, pointing it more perpendicularly, penetrated deeper than the other, and thus at every stroke giving to the mandible a direction more vertical, wounding and cutting wider and deeper, precisely in the manner of the insect in possession of all its parts and powers. The sensation at each thrust was like that of a pin, and equally painful; and when the mandibles were withdrawn, the blood flowed as freely. The head

continued to give signs of life for more than thirty-six hours after decapitation. The body to which it belonged lived still longer, or more than forty-eight hours."

It is a very remarkable fact that the insect should be so tenacious of life under circumstances that would be instantly fatal to most creatures, and yet should die suddenly under conditions in which many insects live and thrive. The reader will remember that the direct action of the sun's rays will kill the Driver Ant in less than two minutes, and yet there are Ants of the same country which run about freely in the blazing sunshine, traversing with impunity the heated ground, which blisters the bare hand, and being able to secrete abundant stores of the liquid which they use in making their habitation.

In Dr. Livingstone's well-known work, there are several interesting accounts of Ants and their habits, and one anecdote bears so aptly on the subject, that I give it in the writer's own words.

After describing the terrible drought at Chonuane, when the river Kolobay ran dry and the fish perished, when the crocodile himself was stranded and died, and the native trees could not hold up their leaves, he proceeds as follows: —"In the midst of this dreary drought, it was wonderful to see those tiny creatures, the Ants, running about with their accustomed vivacity. I put the bulb of a thermometer three inches under the soil in the sun at midday, and found the mercury to stand at 132° to 134°; and if certain beetles were placed on the surface, they only ran about a few seconds and expired.

"But this boiling heat only augmented the activity of the long-legged Black Ants; they never tire; their organs of motion seem endowed with the same power as is ascribed by physiologists to the muscles of the human heart, by which that part of the frame never becomes fatigued, and

which may be imparted to all our organs in that higher sphere to which we fondly hope to rise.

"Where do these Ants get their moisture? Our house was built on a hard, ferruginous conglomerate, in order to be out of the way of the White Ant, but they came despite the precaution; and not only were they in this sultry weather able individually to moisten soil to the consistency of mortar for the formation of galleries, which in their way of working is done by night (so that they are screened from the observation of birds by day in passing and repassing towards any vegetable matter they may wish to devour), but, when their inner chambers were laid open, these were also surprisingly humid; yet there was no dew, and the house being placed on a rock, they could have no subterranean passage to the bed of the river, which ran about three hundred yards below the hill. Can it be that they have the power of combining the oxygen and hydrogen of their vegetable food by vital force as to form water?"

In corroboration of this opinion, Dr. Livingstone mentions an insect found in Angola, and which is allied to the common cuckoo-spit of England, which has the property of pouring out great quantities of water, so that a group of seven or eight insects will produce three or four pints of water in the course of the night. After stating that he believes the water to be produced, not from the sap of the tree, but from the atmosphere, he proceeds as follows:—

"Finding a colony of these insects busily distilling on a branch of the castor-oil plant, I denuded about twenty inches of the bark on the tree-side of the insects, and scraped away the inner bark, so as to destroy all the ascending vessels. I also cut a hole in the side of the branch, reaching to the middle, and then cut out the pith and internal vessels. The distillation was then going on at

the rate of one drop in each sixty-seven seconds, or about two ounces five and a half drachms in twenty-four hours. Next morning the distillation, so far from being affected by the attempt to stop the supplies, supposing they had come up through the branch from the tree, was increased to a drop every five seconds, or twelve drops per minute, making one pint in every twenty-four hours.

"I then cut the branch so much that during the day it broke; but they still went on at the rate of a drop every five seconds, while another colony on a branch of the same tree gave a drop every seventeen seconds only, or at the rate of about ten ounces four and one-fifth drachms in every twenty-four hours. I finally cut off the branch; but this was too much for their patience, for they immediately decamped, as insects will do from either a dead branch or a dead animal. The presence of greater moisture in the air increased the power of these distillers; the period of greatest activity was in the morning, when the air and everything else was charged with dew."

Three species of Driver Ant are known, namely, the common species, which has already been described, *Anomma Burmeisteri*, and a smaller species, *Anomma rubella*.

The two first insects are deep, shining black, and resemble each other so closely that an unpractised eye could not distinguish between them, while the last may be easily known by its brownish red hue.

The specimens which have already been mentioned are now before me, and curious beings they are. The largest are black, with a slight tinge of red, and have an enormous head, almost equalling one-third of the entire length. It is deep and wide as well as long, as indeed is necessary for the attachment of the muscles which move the enormous jaws. These weapons are sharply curved, and when closed, they cross each other, so that when the insect has

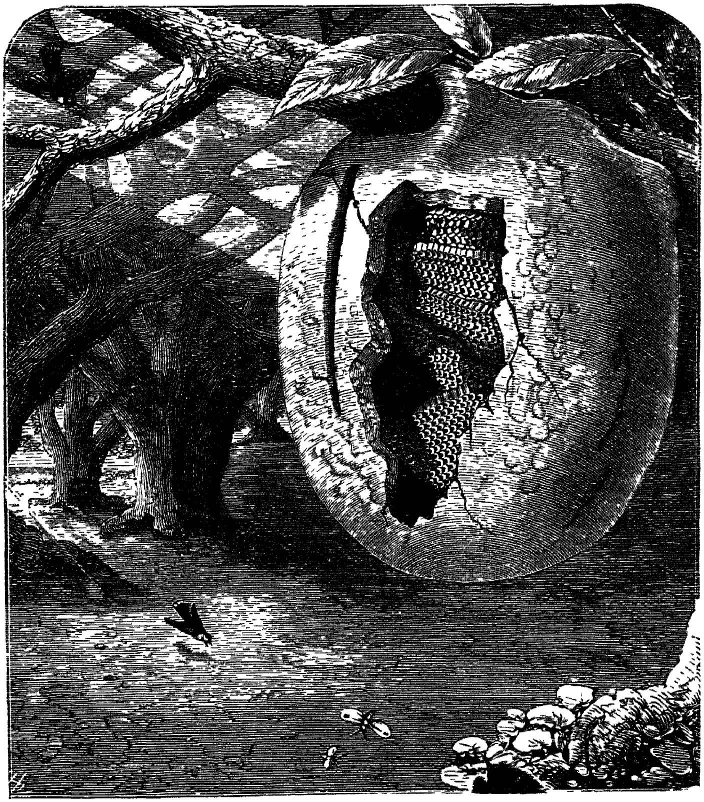
fairly fixed itself, its hold cannot be loosened unless the jaws are opened. It is useless, therefore, to kill the Ant, for its head will retain its grasp in death as well as in life. Beside the sharp points of the mandibles, they are further armed with a central tooth, which is so formed that when the mandibles are quite closed, and the points crossed to the utmost, the tips of the central teeth meet and form another means of grasping.

There is no vestige of external eyes, and even the half-inch power of the microscope fails to show the slightest indication of visual organs. As, however, the horny coat of the head is sufficiently translucent to permit the articulation of the jaws to be seen through it, when a very powerful light is thrown upon the head and the eyes of the observer are well sheltered, it is possible that the insect may have some sense of sight, and at all events will be able to distinguish light from darkness.

The limbs are of a paler red than the body, and although they are slender and delicate, their grasping power is very great. Two of my specimens had grasped each other's limbs with such force that they could not be separated without damaging the insect, and it was not until the rigid joints were softened with moisture, and then with the aid of a magnifier, that I succeeded in disengaging the insects.

The smaller specimens are not so black as the larger, nor are their jaws so proportionately large, but they are still formidable insects, if not from their individual size, yet from their collective numbers and their reckless courage, which urges them to attack anything that opposes them. Fire will frighten almost any creature, but it has no terrors for the Driver Ant, which will dash at a glowing coal, fix its jaws in the burning mass, and straightway shrivel up in the heat.

In the collection of the British Museum may be seen a very remarkable nest, which is made by some species of wasp at present unknown.



MUD WASP

The material of which it is formed is mud, or clay, which is kneaded by the insect until it has attained a wonderful tenacity and strength, and is rendered so plastic as to be worked almost as neatly as the waxen bee-cell. It is of

rather a large size, measuring about thirteen inches in length, by nine in width, and filled with combs. Unfortunately, in its passage to this country, it was broken and much damaged, but the fragments were collected and skilfully put together by Mr. F. Smith, who has succeeded in restoring the nest to its original shape, with the exception of an aperture through which the interior of the nest may be seen.

The accident was in so far an advantage, that it gave opportunities of studying the construction of a nest which is at present unique, and which the officers of the Museum might be chary of cutting open, particularly as its materials are so brittle. The walls of the nest are remarkably hard and solid, but extremely variable in thickness, some parts being nearly three times as strong as others. The upper portions of the nest are the thickest, the reason for which is evident on inspecting the specimen.

The nest was found in a Guianan forest, near the river Berbice, suspended to a branch, which passed through a hole in the solid wall of the nest. In the actual specimen the branch is wanting; but in the illustration it has been restored, in order to show the manner in which the winged artificers suspended their wonderful home. As is always the case with pensile nests, the foundation is laid at the top, thus carrying out Dean Swift's suggestion for a new patent in architecture. A large quantity of clay is worked round the chosen branch, and made very strong, in order to sustain the heavy weight which will be suspended from it. This clay foundation is wonderfully hard, though very brittle, this latter quality being probably due to the long residence in a room which is always kept warm and dry by artificial means. In the open air, and in the ever-damp, though hot atmosphere of tropical America, the clay would probably be much tougher, without losing the necessary hardness.

The combs are not flat, like those of an ordinary wasp-nest, but are very much curved, so that when the nest is laid open they almost follow the curve of the walls. This peculiar form of the comb is shown in the illustration. The cells are not very large, scarcely equalling the worker cells of the common burrowing wasp of England.

One of the most remarkable points in the construction of this nest is the entrance. In pensile nests, the insect usually forms the opening below, so that it may be sheltered from the wind and rain. Moreover, it is usually of small dimensions, evidently in order to prevent the inroads of parasitic insects and other foes, and to give the sentinels a small gateway to defend. But the particular Wasp which built this remarkable nest seems to have set every rule at defiance, and to have shown an entire contempt of foes and indifference to rain.

As may be seen by reference to the illustration, the entrance is extremely long, though not wide, and extends through nearly the length of the nest, so that the edges of the combs can be seen by looking into the aperture. The edges of the entrance are rounded, so that the outer edge is wider than the inner; but it is still sufficiently wide to allow the little finger of a man's hand to be passed into the interior; while its length is so great, that forty or fifty insects might enter or leave the nest together.

The remarkable fact has already been mentioned, that two species of Wasp will inhabit the same nest, and amicably work at the same edifice. Entomologists have long been aware that two species of Ant will dwell in the same nest, and live upon friendly terms, although the association of the working part of the community is not voluntary, but compulsory.

The Ant which employs enforced labour is called the

AMAZON ANT, and is tolerably common on the Continent. This insect is not furnished with jaws which are capable of performing the work that usually falls to the lot of the neuters; but the same length and sharpness of the mandibles which unfit the insect for work, render it eminently capable of warfare. When, therefore, a colony of the Amazon Ants is about to establish itself, the insects form themselves into an army, and set off on a slave-hunting expedition.

There are at least two species of Ant which act as servants to the Amazon Ants, the one being named *Formica fusca*, and the other *Formica cunicularia;* and to the nests of one or other of these insects the Amazons direct their march.

As soon as they reach the nest, they penetrate into all its recesses, in spite of opposition, and search every corner for their spoil. This consists solely of the pupæ which will afterwards be developed into neuters; and vast numbers of the unconscious young are carried off in the jaws of the conquerors. The rightful owners and relatives of the captured young cannot resist the enemy, as their shorter though more generally useful jaws are unable to contend with the long and sharply-pointed weapons of their foes.

After the marauding army has returned, the living spoils are carefully deposited in the nest, where they are speedily hatched into perfect insects of the worker class, and immediately take on themselves the labours of the nest, just as they would have done in their own home. The Amazon Ant seems to be utterly incapable of work; and in one notable instance, when a number of them were confined in a glass-case, together with some pupæ, they were not only unable to rear the young, but could not even feed themselves, so that the greater number died

from hunger. By way of experiment, a single specimen of the slave Ant (*Formica fusca*) was introduced into the case, when the state of affairs was at once altered. The tiny creature undertook the whole care of the family, fed the still living Amazon Ants, and took charge of the pupæ until they were developed into perfect insects.

Some writers have enlarged upon the hard lot of the slave Ants, imagining their servitude to be as distasteful to them as it is sometimes made to human slaves. Mr. Westwood, however, points out very clearly that any compassion bestowed upon them is wasted, and that the lot of the "helots"—if they may be so called—is precisely that for which they were made. The labours which the little creatures undertake are not arbitrarily forced upon them by the dread of punishment, but are urged upon them by the instincts implanted within them. They would have worked in precisely the same manner and with exactly the same assiduity in their own nests as in that of their captors, and the labours are undertaken as willingly in the one case as in the other.

They find themselves perfectly at home, and are in every respect on a par with their so-called masters. In point of fact, however, the real masters in the nest are the slaves, for upon them the Amazons are dependent from their earliest days to the end of their life, and without them the entire community would perish. The slaves have no other home but that to which they have been brought, and are no more to be pitied than are dogs, cattle, and other domestic animals that never have freedom. Indeed, none but solitary animals can be free even in the wild state, for they are held in absolute servitude by the leaders of the herds, and, if they dare to disobey, are summarily punished.

As the slaves are always neuters, it is necessary that

fresh importations should be made as fast as the demand for workers exceeds the supply; and it is really a wonderful thing that the Amazon Ants should always select the pupæ which will afterwards be developed into neuters, and never take those from which males or females will issue.

The Amazon of the Continent is not the only Ant which enslaves the neuters of another species, for in different parts of the world several species of Ants have been observed which seize upon workers belonging to other nests, and bring them to do the work of the home. A Brazilian species has been observed to act in a similar manner.

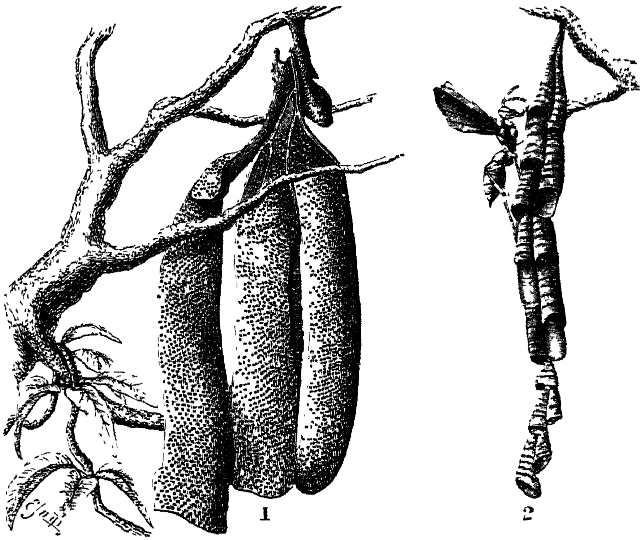
In the accompanying illustration are shown two remarkable nests, made by insects of the same genus, which have been placed side by side in order to show the different manner in which cells are arranged by insects which are closely allied to each other.

The smaller, though more conspicuous nest, is formed by an insect which is called *Polistes aterrima*, a name which is very appropriate to the creature, inasmuch as the generic title signifies a builder, or the founder of a city, and the specific name signifies intense blackness, and is given to the insect on account of its colour. In general shape the insect resembles other species of its genus, but is rather larger than the generality of its kin, and is conspicuous for its deep black colour.

The method of nidification which this species adopts is very peculiar. The cells are formed with beautiful regularity, but are arranged in a very curious fashion. They are placed with their mouths downwards, as is frequently the custom with the cells of hymenoptera, but are not quite perpendicular, inclining alternately to either side. Each cell is set rather lower than its predecessor, so that the

general effect is very peculiar, and gives to the cell-group a character which renders it at once recognisable.

The second nest which is represented in the same illustration is scarcely so striking in appearance as the preceding, but is equally interesting, and to many minds more so, because the architect is at present unknown, and there is



NESTS POLISTES ATERRIMA, ETC

some little mystery about the edifice. That it is the work of a Polistes is evident enough from the character of the cells, but it is not made by any of the numerous species whose nests are already in European collections.

The colour of the combs is a rather sombre brown, so that at a little distance the whole group would easily escape notice, especially if it were buried in the depths of the forest, as is the case with many similar nests. The cells

are about the same size as those of the curious clay nest which has already been described, but they are undefended by any covering, and exposed to the weather.

It has been suggested by some observers that the combs might have been originally protected by an outer case, and that the case itself has been lost. The formation of the branch, however, from which the combs are hung, serves to militate against any such theory, as the twigs project so far that they must have been enveloped by the covering if it ever existed, while upon them there is no trace of any such material as that of which the nest is made. The inference is, therefore, that they were never intended to be protected by a cover, but that they were intentionally exposed to the air, as is the case with the habitations of Polistes and several allied insects, whose homes will shortly be described.

One of the most curious points in the construction of this nest is the manner in which it is suspended to the branch. As is shown in the illustration, the combs are comparatively narrow at the point of attachment, and gradually increase in width, so that their weight, when filled with the young brood, must be considerable, and the strain on the upper part of the comb very great. The manner in which the insect has met this difficulty is really wonderful. It has not made the upper part of the comb to consist of a solid mass, as is the case with the clay nest which has just been described, but has utilised almost every portion of the comb from the top to the bottom. But, in order to obtain the needful strength, the upper part is constructed after a manner that is widely different from that which prevails upon the lower and wider portion of the comb.

If one of the combs were broken across, the lower half would much resemble, except in colour, the nest of an

ordinary wasp, except that the cells are smaller, and the material stronger. But, towards the top, the partitions between the cells become thicker, and in consequence the cells are fewer. This increased strength is chiefly found in the partitions which run perpendicularly, and which are so thick, that the hexagonal form of the cells becomes obscured, the great object being, not the exact shape of the cells, but their ability to bear the weight of the comb below.

The general effect of this modification can be easily imitated by taking an oblong piece of linen, rounding the corners, and plaiting one end, just as ladies gather in the upper part of an apron. The longitudinal folds will then represent the perpendicular partitions of the cells, and will show how strength is gained without needless expenditure of material. The strengthened partitions do not run quite perpendicularly, but are slightly irregular, just as would be the case with the folds of the linen if it were fastened to a branch by the plaited end, and suffered to hang loosely.

The history of Social Insects would be incomplete without the mention of several British insects, which are plentiful enough, but which are scarcely known as well as they deserve. These are the creatures which are popularly known as CARDER BEES, because they prepare the materials for their nest in a manner similar to that which is employed in carding cotton wool or heckling flax

Several species of Carder Bee are known, all belonging to that familiar group of insects called Humble Bees. Among these, as among Humble Bees in general, there is a great variety of colour, so that the same species has been called by different names, even by skilled entomologists. For example, in Kirby's admirable monograph of British

Bees, no less than seven varieties of the commonest species of Carder Bee are given as separate species.

That such mistakes should be made is no matter of surprise when we take into consideration the capriciousness with which the colours of this species are distributed among its members. Among the queen Bees, the abdomen is sometimes marked with rings of yellow, black, and red, and is sometimes red at the base and tip and black in the middle. The worker has usually a yellowish abdomen, with one or two blackish bands, but in some cases the whole abdomen is black, except a small patch on the base and another at the tip. The male Bee has generally the abdomen coloured like the first mentioned example of the worker, but sometimes it is wholly black, and in many cases it is black except the tip, which is dun. Indeed, these insects are so extremely variable, that the only method of determining their true arrangement is by taking a great number of nests, breeding the inmates, and subjecting them not only to careful external examination, but also to dissection of their internal anatomy.

The specific title "muscorum," *i.e.*, "of the mosses," which is given to this Bee, is due to the material of which the nest is usually made. It was generally thought to be made exclusively of moss, but is in fact constructed of various substances, according to the locality. Mr. F. Smith mentions several instances where the Bees had made use of very singular and unexpected materials.

In one case, Bees were seen flying into a stable through the latticed window, collecting the little hairs that had fallen from the horses during the process of currying, making them up into bundles, and flying off with them. On being watched carefully, one of the Bees was seen to alight on some grass, not very far from the stable, and among the grass was found the nest, which was composed entirely

of horsehair. Unfortunately this remarkable nest was destroyed before it was completed.

Another very interesting deviation from the usual economy of the moss-building Bees was observed by Dr. William Bell. During the summer of 1854, a robin built its nest in the porch of his cottage at Putney. Some time after this had been observed, a Humble Bee took possession of the nest, and adapted it to her own purpose. He was unfortunately unable to identify the species by capturing a specimen, the nest having been destroyed; but Dr. Bell saw the Bee on one occasion, and observed that it was black, with yellow bands.

Moss, however, is the favourite material of the Carder Bees, and wherever it can be obtained, they will use no other substance, though in places where it is scarce, or not to be found, they employ leaves, grass, or any other suitable material. Whatever may be the material, the Bee always takes great pains to disentangle the fibres, in order to be able to weave them in a systematic manner into the nest. This process is conducted by means of the legs, the Bee seizing the fibre with her fore-feet, and passing it under her body by means of the remaining pairs of legs, forming it, as she does so, into a small bundle which can be easily carried off.

The object of the moss and other substances is very simple. The Carder Bees do not build their nests, like those of many Humble Bees, beneath the surface of the ground, but upon it choosing a spot where there is a slight hollow of an inch or two in depth. The moss is then woven so as to form a domed cover to the cells, this dome being of variable dimensions, according to the number of cells which it covers, but seldom reaching more than three or four inches in height above the ground. As in very rainy weather this mossy dome would not be waterproof, the

insects line it with a very coarse, dark-coloured wax, similar to that of which the breeding cells are made.

The entrance to the nest is always at the bottom; for although the insects will sometimes make an opening at the top, they seem to do so merely for the purpose of admitting air and warmth, and never enter or leave the nest through it, closing it at night or in rainy weather. Generally, a kind of tunnel or arched entrance leads into the nest, like the passage into an Esquimaux snow-house, an edifice to which the moss-covered dome of the Carder Bee bears no small resemblance.

The best time to search for these Bees is in the hay-making season, when the scythe-men often come upon them during their work; and a promise of some small reward for this or any other structure will probably produce a tolerable harvest of nests, as well as of hay.

CHAPTER V.

PARASITIC NESTS.

Various Parasites—Parasitic Birds—The CUCKOO and its kin—The COW BIRD and its nest—Size of its egg—Comparison between the Cuckoo and the Apteryx—The ÆPYORNIS—The BLUE-FACED HONEY-EATER or BATIKIN—General habits of the bird—Singular mode of nesting—The SPARROW-HAWK and its parasitic habits—The KESTREL—Its quarrel with a Magpie—The PURPLE GRAKLE or CROW BLACKBIRD—Its curious alliance with the Osprey—Wilson's account of the two birds—The SPARROW as a parasite—Curious behaviour of the STORK—Parasitic insects—The ICHNEUMON FLIES—The parasite of the CABBAGE CATERPILLAR—Its numbers and mode of making its habitation—Trap-doors of the cells—The Australian Cocoon and its parasites—The OAK-EGGER MOTH—Its cocoons and enemies—The PUSS MOTH—Its remarkable cocoon—Powerful jaws of the parasite—RUBY-TAILED FLIES and their victims—Modes of usurpation—The CUCKOO FLIES or Tachinæ—Parasites within pupæ—Parasites on vegetables—The GALL FLIES and their home—British Galls: their shapes, structures, and authors—Foreign Galls, and their uses

WE now pass to another branch of natural history, and come to those creatures that are indebted to other beings for their homes. In some cases, the habitation is simply usurped from the rightful proprietors, who are either driven out by main force or are ousted by gradual encroachment. In other cases, the deserted tenement of one animal is seized upon by another, which either inhabits it at once, or makes a few alterations, and so converts it to its own purposes. In many instances, however, the habitation of the parasite is found within the animal itself; and

in some cases the entire body forms the home of the parasite.

Many examples of the first description may be given. For instance, where the puffin invades the rabbit-burrows, and drives out the rabbits by dint of courage and a powerful beak; or where the Coquimbo owl and rattlesnake take possession of the homes which had been excavated by the prairie dog. Examples of the second description of parasites have also been given. The kingfisher, for instance, usurps the deserted hole of a water-shrew; and the humble-bee and wasp usually take advantage of the deserted burrow of some rat or mouse. In the account of the sociable weaver-bird, mention is also made of certain little green parrots, which are apt to take possession of the great nest, and use it for their own purpose. And an instance has been recorded where a carder-bee established herself in the deserted nest of a wren, and so saved herself the trouble of fetching materials and building a dome.

Birds of various kinds are notorious parasites, the Cuckoos ranking as chief among them, inasmuch as they make no nest at all, but simply lay their eggs in the nests of other birds, and foist upon them a supposititious offspring, which occupies the entire nest and monopolises all the care of its foster-parents.

All Cuckoos, however, do not possess this habit; for some of the group build nests which are remarkable for their beauty, and tend their young as carefully as do any birds. The celebrated Honey-finders, for example, which are found in most hot portions of the globe, are notable for their skill in architecture. The nests of these birds are pensile, and not unlike those of the African weaver-birds, which have already been described. They are made of

tough bark, torn into filaments, and are flask-like in shape, hung from the branches of trees, and having their entrance from below.

Then there is the well-known COW-BIRD of America, which is closely allied to the common cuckoo, and yet which builds its own nest, and rears its own young. "Early in May," writes Wilson, "they begin to pair, when obstinate battles take place among the males. About the tenth of that month they commence building. The nest is usually fixed among the horizontal branches of an apple-tree; sometimes in a solitary thorn, crab, or cedar, in some retired part of the woods. It is constructed with little art, and scarcely any concavity, of small sticks and twigs, intermixed with green weeds and blossoms of the common maple. On this almost flat bed the eggs, usually three or four in number, are placed; these are of an uniform greenish blue colour, and of a size proportionate to that of the bird.

"While the female is sitting, the male is generally not very far distant, and gives the alarm by his notes when any person is approaching. The female sits so close that you may almost reach her with your hand, and then precipitates herself to the ground, feigning lameness, fluttering, trailing her wings, and tumbling over, in the manner of the partridge, woodcock, and many other species. Both parents unite in providing food for the young."

In this narrative, two points are especially worthy of notice. In the first place, the egg of the Cow-bird is proportionate in size to the bird which laid it. Now, one of the most remarkable facts connected with the history of the common cuckoo is, that although the bird is as large as a small hawk, its egg is scarcely half as large as that of a thrush or blackbird, as indeed is needful for its admission into the nest of a hedge-sparrow or redstart.

Here, then, we have an example of a bird laying an egg which is extremely small in proportion to its own size, while in the apteryx or kiwi-kiwi of New Zealand, we have an example of a bird laying an egg which is absolutely gigantic in proportion to its own size. The apteryx is not a large bird, certainly not larger than a guinea fowl, and yet its egg looks like that of a swan, and weighs just one quarter as much as the bird which produced it. Thus it is evident that the dimensions of an egg afford no certain criterion respecting the size of the bird that laid it, and although a large bird usually lays a large egg, and a small bird lays a little one, the cases *may* be reversed, as in the instance just mentioned.

All naturalists are familiar with the gigantic egg laid by some bird unknown, and called by the provisional name of *Æpyornis*, or "tall-bird." This egg makes that of the ostrich itself shrink into insignificance, for its lineal measurement is precisely double that of a large ostrich egg, and its cubic bulk is eight times as great. In fact, the æpyornis egg looks as gigantic by the side of an ostrich egg as does an ostrich egg near that of a duck. It was therefore imagined that the æpyornis must be at least eight times as large as the ostrich, and a height of sixteen feet was attributed to the unknown bird.

Now, it is easy to work out this problem by the rule of three, and to give the result in figures; but when that result is compared with existing facts, it becomes startling. On paper, a height of sixteen feet for an ostrich-like bird seems rather gigantic, but does not appear to carry with it any idea of its real magnitude. The height of a very fine ostrich being about seven or eight feet, we say that the æpyornis must be twice as tall as an ostrich, and so dismiss the subject from our minds. But, when we come to compare the imaginary bird with actually existing beings,

we shall better understand the dimensions of a bird that measured sixteen feet in height. Sixteen feet is the average height of the adult giraffe, the females varying from thirteen to sixteen feet, and the males from fifteen to eighteen.

It is impossible to say that there never was a bird as large as a giraffe, but all our present knowledge controverts such an idea. If, however, we keep in mind the comparative dimensions of the apteryx and its egg, we must be prepared to find that the æpyornis, although necessarily a large bird, may not be larger than an ostrich, and need not be so large.

Thus, then, the comparative size of an egg is by no means an unimportant fact in natural history, and the comparison of two such birds as the apteryx and the cuckoo may at least save us from the danger of generalising too hastily.

The second point in the history of the Cow-bird is its love for its young, which is quite equal to the affection that is manifested by the lapwing and other birds that endanger themselves in order to draw attention away from their offspring, and directly opposed to the indifference towards the young which seems to actuate the ordinary cuckoo.

In Australia there is a large group of rather pretty birds, popularly called Honey-eaters, because they feed largely on the sweet juices of many flowers, although the staple of their diet consists of insects. They seem indeed to occupy in Australia the position which is taken in America by the humming-birds, and by the sun birds of the Old World. To this group belong many familiar and interesting species, such as that which produces a sound like the tinkling of a bell, and is in consequence called the Bell-bird; the different species of Wattle Birds; the odd, bald-headed Friar Birds, and the splendidly decorated Poe Birds.

One species of it, which comes in the present section, is the BLUE-FACED HONEY-EATER of New South Wales, called by the natives BATIKIN. It is a pretty bird, the plumage being marked boldly with black and white, and a patch of bare skin round the eyes being bright azure.

HONEY-EATER IN NEST

This peculiarity has earned for the bird the specific title of *cyanotis*, or "blue-eared."

Like all the Honey-eaters, it is a most lively and interesting bird, and to the careful observer affords an endless fund of amusement. It is never still, but traverses the branches with astonishing celerity, skipping from one to another, probing every crevice with its needle-like tongue,

hanging with its head downwards, and even suspending itself by a single claw, while it secures a tempting insect. It is generally to be found on the eucalypti, or gum-trees, and is one of the stationary birds, remaining in the same locality throughout the year.

The generality of the Honey-eaters are skilful architects, but the Batikin seems not to share the ability of its relatives, or, at all events, not to exercise it. Mr. Gould thinks that the bird can hardly depart so far from usual custom as to be incapable of building a nest, but he has never found such a nest, nor heard of one. The Batikin is one of the parasitic group, usurping the nest of another bird, and taking possession of it in a very curious fashion.

In Australia there is a bird belonging to the genus *Pomatorhinus*, which somewhat resembles the bee-eater, except in plumage, which is quite dull and sober. This bird builds a large, domed edifice, and appears to make a new nest every year. The deserted nests are always usurped by the Batikin, which establishes herself without any trouble. The reader would naturally imagine that when the bird finds herself in possession of so large and warm a nest, she will pass into the interior, and hatch her young under the protection of the roof. This plan, however, she does not follow, preferring to take up her abode on the very top of the nest, exposed to all the elements. She takes very little trouble about preparing her home, but merely works a suitable depression upon the soft dome, lays her eggs in it, and there hatches them.

The reader will remember that there are several birds which form a supplementary nest upon the exterior of the original domicile, and the parasitic nest of the Batikin is evidently an extension of the same principle.

In England we have many parasite birds, one of which

is the common SPARROW-HAWK, which is in the habit of usurping the nest of the common crow, magpie, or other bird, and laying its handsome eggs therein.

Whether it forcibly drives away the rightful owner, or whether it contents itself with a nest which has already been abandoned, is not precisely known, different naturalists inclining to opposite opinions. In all probability, therefore, both disputants are right, and the Sparrow-Hawk takes a deserted nest when it can find one, and when it cannot do so, attacks birds which are in actual possession of a suitable nest, and takes possession of their home. In such a case, the combat must be a sharp one, for both crow and magpie are courageous birds, nothing inferior in determination to their assailant, and armed with bills which are much larger, and quite as formidable as that of the Sparrow-Hawk.

The KESTREL is also in the habit of laying its eggs in the nests of other birds, and may possibly eject the rightful owner by main force. This opinion is rendered probable by a fact mentioned by Mr. Peachey, in the "Zoologist." A man was passing a tree, and hearing a loud screaming proceeding from a nest at the summit, he had the curiosity to climb the tree. The screams still continued, and on putting his hand into the nest, he found two birds struggling, the uppermost of which he caught. This proved to be a Kestrel, and as soon as it was secured, the other bird, which was a magpie, flew out, evidently having been worsted by its antagonist.

Then there is the well-known STARLING, which is a notably parasitic bird, delighting to take the nests of the jackdaw, pigeon, and other birds, and to use them as its own. Every one who has a dovecot knows how apt are the Starlings to usurp the boxes intended for the pigeons, and

OSPREY AND GRAKLES.

how in consequence it is accused of killing the young of the pigeons, and sucking their eggs, two accusations which I believe to be wholly false. Were the Starlings to be thus predaceous, the pigeons would be quite aware of their depredations, and would appear greatly disturbed whenever the robbers were seen. As, however, the pigeons in one box live in perfect amity with the Starlings in the next, it is very unlikely that the latter birds prey in any way upon the former.

There is a group of birds which are popularly called Grakles, and are scientifically known as Quiscalinæ. They are also called Boat-tails, because their tail-feathers are formed so as to take the shape of a canoe. One species, the Purple Grakle, or Crow-Blackbird, is conspicuous as a parasitic bird, and selects a most extraordinary spot for its nest.

Generally, the predaceous birds are avoided and feared by the rest of the feathered tribes, and if a hawk or eagle show itself, the smaller birds either hide themselves, or try to drive away the intruder by force of numbers or swiftness of wing. The Purple Grakle, however, is devoid of such fears, at all events as far as one species of predaceous bird is concerned, and boldly takes up its abode with the osprey or fish-hawk.

The nest of the osprey is a very large edifice, made of sticks, grass, seaweed, leaves, and similar materials. The foundations are made by sticks almost as thick as broom-handles, and some two or three feet in length, on which are piled smaller sticks, until a heap some four or five feet in height is made. Interwoven with the sticks are stalks of corn and various herbs, the larger seaweeds and large pieces of grass, the whole mass being a good load for an ordinary cart, and as much as a horse

can be reasonably expected to draw. The bird retains the nest year after year, and, as has been shown from actual observation, the same spot has been occupied for so long a term that the branches of the tree became rotten, and the nest fell to the ground. In this case it is evident that a succession of birds must have occupied the same nest.

It has been observed that whenever a tree is occupied by the osprey, it dies in a short time, though no one is aware of the precise nature of the injury which kills it. Some persons say that the fish-oil which is spilled by the birds is the cause of death; but when we remember that there is no better manure than fish, we can hardly believe that the alleged cause is the real one. Other persons think that the real cause of death is the huge mass of decaying vegetable and animal substances which is placed on the branches, and that the drippings from the nest fall into casual interstices of the branches, and gradually kill it from above downwards. So firmly are the materials interwoven, that when a tree falls on which an osprey nest is built, large masses of the nest hold together in spite of the shock.

The construction of the osprey nest has been described somewhat at length, because the manner in which the Purple Grakle becomes a parasite could not be understood unless the structure of the nest were comprehended.

As the sticks of which the foundation of the nest are made are very large, and not regular in form, considerable interstices are left between them, and in such spots the Grakle chooses to nidificate.

In writing of the osprey, Wilson remarks as follows: "There is one singular trait in the character of this bird which is mentioned in treating of the Purple Grakle, and which I have had many opportunities of witnessing. The

Grakles, or Crow-Blackbirds, are permitted by the fish-hawk to build their nests among the interstices of the sticks of which its own is constructed,—several pairs of Grakles taking up their abode there, like humble vassals around the castle of their chief,—laying, hatching their young, and living together in mutual harmony. I have found no less than four of these nests clustered round the sides of the former, and a fifth fixed on the nearest branch of the adjoining tree, as if the proprietor of this last, unable to find an unoccupied corner on the premises, had been anxious to share, as much as possible, the company and protection of this generous bird.' In another place, the same writer remarks that the curious allies "mutually watch and protect each other's property from depredators."

These Grakles exist in great numbers, and sweep over the land in vast flocks, like our own starlings, their wings sounding like the blast of a tempest as they rise from the ground, and their bodies darkening the air. "A few miles from the banks of the Roanoke, on the 20th of January, I met with one of these prodigious armies of Grakles. They rose from the surrounding fields with a noise like thunder, and, descending on the length of road before me, covered it and all the fences completely with black; and when they again rose, and, after a few evolutions, descended on the skirts of the high timbered woods, they produced a most singular and striking effect, the whole trees, for a considerable extent, seeming as if hung in mourning; their notes and screaming the meanwhile resembling the distant sound of a great cataract, but in more musical cadence, swelling and dying away on the ear, according to the fluctuations of the breeze."

It is evident that such vast multitudes of birds cannot all have been nurtured in the interstices of osprey nests.

Indeed, the generality of the birds build in tall trees, usually associating together, so that fifteen or twenty nests are made in the same tree. The nests are well and carefully made of mud, roots, and grasses, about four inches in depth, and warmly lined with horsehair and very fine grasses. The fact that the bird possesses this capability of nest-building gives more interest to the occasional habit of sharing its home with the osprey—a privilege of which it seems to avail itself whenever an osprey's nest is within reach.

The colour of this bird appears at a little distance to be black, but is in reality a very deep purple, changing in different lights to green, violet, and copper, and having a glossy sheen like that of satin.

Our little friend the SPARROW is occasionally a parasite, following to some extent the custom of the purple grakle, though it does not select a bird of prey for its companion.

On the Continent, the common stork builds largely, and in several countries is protected by general consent, the slaughter of a stork, or the destruction of its nest and eggs, being visited with a heavy fine.. In consequence of this immunity, the stork is very tame, building upon houses as freely as does the martin, and being considered as a bringer of good luck when it does so.

Any disused chimney is sure to have a stork's nest upon the top, and so is a pillar, or any ruin. The nest of the stork bears a general resemblance to that of the osprey, and with the exception of the seaweed, is made of similar materials. It is of huge dimensions, and chiefly consists of sticks and reeds, heaped together without much arrangement, and having on the top a slight depression, in which the eggs are laid. As is the case with the osprey nest,

considerable interstices are left between the sticks, and in these spots the Sparrow loves to place its nest. Mr. F. Keyl has told me that he has repeatedly seen the storks and Sparrows thus living in amity together, the stork appearing to extend to a weaker bird that protection which it receives from mankind.

We now pass to the Parasitic Insects. As this work is intended to describe dwellings which are in some way formed by the creatures, it is necessary to exclude all the parasite insects that may exist upon the animal, and make no habitation, such as the ticks, as well as those which are merely parasitic within the animal, such as the various entozoa.

Of Parasitic Insects, the greater number belong to that group of hymenoptera which is called Ichneumonidæ, and which embraces a number of species equal to all the other groups of the same order. Being desirous of producing, as far as possible, those examples of insects which have not been figured, I have selected for illustration several specimens which are now in the British Museum, one or two of which have only been recently placed in that collection.

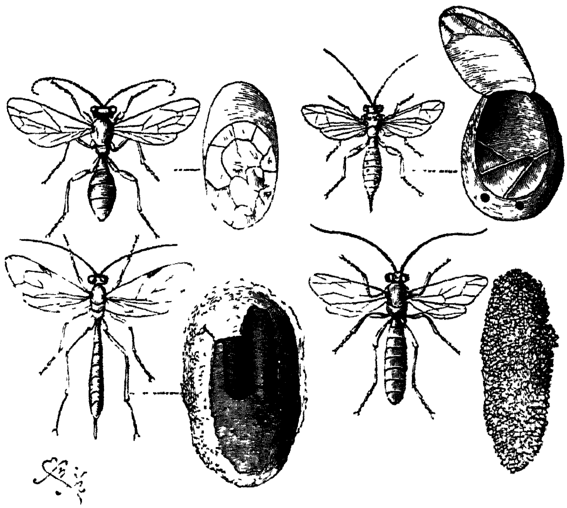
The best known of all the Ichneumonidæ is that tiny creature called *Microgaster glomeratus*.

A group of these insects and their cells is now before me, and will be briefly described.

The insects themselves much resemble in general form the Burnet ichneumon, but are smaller, blacker, and not nearly so beautiful, although their wings gleam with an iridescence nearly as brilliant. Small as it is, this tiny insect is extremely valuable to us, and to the gardener is beyond all value, though, as a general rule, the gardener

knows nothing about it. Were it not for this ichneumon, we should scarcely have a cabbage or a cauliflower in the garden; for the noisome cabbage caterpillars would destroy every leaf of the present plant, and nip the growth of every bud which gave promise for the future.

Every one knows the peculiarly-offensive caterpillars



PARASITIC INSECTS.

Cocoon of Oak-Egger Moth
Cocoon of Puss Moth
Cocoon from New South Wales
Cocoon of Goat Moth.

which eat the cabbages, and which are the offspring of the common large white butterfly. In the spring, the butterflies may be seen flitting about the gardens, settling on the cabbages for a few moments, and then flying off again. They look very pretty, harmless creatures, but, in fact, they are doing all the harm that lies in their power. Forty or fifty eggs are thus laid on a plant, and if only one quarter of the number are hatched, they are quite capable of marring every

leaf. In process of time, they burst from the egg-shell, and commence their business of eating, which is carried on without cessation throughout the whole time of the larval existence, with a few short intervals, while they change their skins.

When they are full grown, they crawl away from the plant to some retired spot, and there suspend themselves, preparatory to changing into the pupal condition. A few of them succeed in this task, but the greater number never achieve the feat, having been the unwilling nourishers of the ichneumon flies. Just before the larva is about to pass into the pupal state, a number of whitish grubs burst from its sides, and each immediately sets to work at spinning a little yellow, oval cocoon. The walls of the cocoon are hard and smooth, especially in the interior; but the outside is covered with loose floss-silk, which serves to bind all the cocoons together. Generally, they are very loosely connected; but a group of these little objects is now before me, where the cocoons are formed into a flattish oval mass, about the size and shape of a scarlet-runner bean, split longitudinally, and are bound so tightly together, that their shape can barely be distinguished through the enveloping threads.

As is the case with the cells of the Burnet ichneumon, each cell is furnished with a little circular door, which exactly resembles in shape and dimensions the circular pieces of paper that are punched out of the edges of postage-stamps. On the average, about sixty or seventy ichneumon flies are produced from a single cabbage caterpillar.

The groups of yellow cells are very plentiful towards the middle of summer and the beginning of autumn, and may be found on walls, palings, the trunks of trees, in outhouses, and, in fact, in every place which affords

shelter to the caterpillar. Nothing is easier than to procure the insects from the cocoons, as the yellow mass needs only to be put into a box, with a piece of gauze tied over it by way of a cover. Nearly every cocoon will produce its ichneumon, and as the little creatures are not strong-jawed enough to bite through the gauze, they can all be secured.

There are many species of Microgaster; but those which have been mentioned are the most important, and make the most interesting habitations.

The large oval cocoon was brought from New South Wales, and is evidently the produce of some lepidopterous insect, probably a moth allied to the silkworm. Upon the larva which constructed the cocoon an ichneumon has laid her eggs, and the consequence has been that the caterpillar has been unable to change into the pupal condition, but has succumbed to the parasites which infested it. These insects are not of minute dimensions, like the Microgaster, but are tolerably large, and in consequence can be but few in number. The cells are very irregular in shape, and are not rounded like those of many Ichneumonidæ, but have angular edges.

In this, and in one or two other examples which are shown in the illustration, the reader will note a peculiarity in the development of the parasite. The Microgaster larvæ emerge from the caterpillar just before it undergoes its change into the pupal condition, and effectually prevent that change by killing the creature in which they had been nurtured. But in many instances the ichneumon larva delays its escape until the caterpillar has completed its cocoon, and in some cases waits until the change into the pupal state has been achieved.

In the present example, the larva has permitted the cocoon to be made, and then killed the caterpillar, the reason of this delay being that the cocoon is very firm and strong, and affords an impregnable shelter to the parasite.

Within the same case there are several cocoons in which a similar calamity has befallen the caterpillars which made them. There is, for example, a cocoon of the OAK-EGGER MOTH, the interior of which resembles that of the insect which has just been described, except that the cells of the parasite are more numerous. This species of caterpillar is peculiarly subject to the attacks of the ichneumon flies, as is well known to all practical entomologists, who lose many of their carefully-bred specimens by means of these insects.

There is also one of the winter cocoons of the GOAT MOTH caterpillar, the inmate of which has been pierced by the ichneumon fly, and killed by its young. As the species of ichneumon is a large one, only a single individual was produced, and as may be seen from the cell of the parasite which is placed by the side of its victim, the habitation of the ichneumon is so large that it must have occupied nearly the entire cocoon of the dead caterpillar.

In another room, placed among the series of British moths, is a cocoon of a PUSS MOTH, which has been occupied by two ichneumon larvæ.

If the reader should happen to know the cocoon of this moth, he will remember that it is made of wood-scrapings, glued together with a cement secreted by the insect, and that its walls are so hard that a tolerably strong knife is required in order to cut it open. That the eggs of a parasite

should be introduced into the body of the larva is not an extraordinary circumstance, but that the perfect insects should be able to make their way out of such a cocoon is really wonderful. The interior of this cell is hard and smooth, as if made of polished ebony, and its concavity renders it more difficult of penetration. Yet these singular insects contrive to make their way through the sturdy walls.

The ichneumons which usually attack the Puss Moth are rather large insects, belonging to the genus *Ophion*, and have long, slender, curved abdomens, and long antennæ slightly twisted at the ends. The colour is orange, diversified with black. Those which have made their cells in the above-mentioned cocoon belong to the species called *Paniscus glaucopterus*, and are of a yellowish hue. It sometimes happens that the insects fail in making their way through the cell-walls and die in the interior. This accident, however, seems chiefly to befall the ichneumons produced in cocoons which are kept in houses for the purpose of breeding the Puss Moth, and which are in consequence harder and more dry than those which remain in the open air, adhering to the trunks of trees.

Those splendid insects which are popularly called RUBY-TAILED FLIES, or FIRETAILS, and scientifically are termed *Chrysididæ*, are also to be numbered among the parasitic insects.

They make no nests for themselves, but intrude upon those of various mason and mining bees, and several other insects. The Firetail does not, however, lay its eggs in the body of the larva, but makes its way into the nest while the rightful owner is absent, and places an egg near that of the bee. The egg of the parasite

is sometimes hatched at the same time with that of the bee, but generally later. In the first instance, the larva feeds on the provisions which were supplied for the bee, and so starves the poor creature to death; and in the latter case, it is not hatched until the young bee is large and fat, and capable of affording ample subsistence to the parasite, which fastens upon it and devours all the softer portions.

Then there are the CUCKOO FLIES, which bear some resemblance to the common house-fly, but which are parasitic, feeding on the larvæ of other insects, and selecting the same species which are persecuted by the firetails. When the Tachina larva has eaten that of the mason bee, it forms an oval cocoon, and there remains until the time for becoming a perfect insect. A single larva of the mason bee seems to be sufficient for the Tachina grub, as Mr. Rennie has recorded an instance where two larvæ of the mason bee were in a nest into which a single egg of a Tachina had been introduced. The parasitic larva devoured one of the rightful inhabitants, but did not touch the other, and the cocoons of the bee and the Tachina were formed side by side.

Sometimes, as has already been mentioned, the chrysalis itself of a lepidopterous insect becomes the home of the parasite. I have found the pupæ of various butterflies absolutely filled with tiny ichneumon flies of the most brilliant colours; and in the British Museum there is an excellent example of a chrysalis, which has been filled by a single ichneumon fly, of such a size that the little chrysalis from which it was taken seems scarcely capable of holding it and its cocoon.

We now pass to a remarkable series of insects belong-

ing to the same order as the ichneumons, but parasitic upon vegetables and not on animals. Their scientific name is *Cynipidæ*, and they are popularly known as GALL FLIES, because they cause those singular excrescences which are so familiar to us under the name of Galls. This group comprises a vast number of species, all of which have a strong family resemblance, though they greatly differ from each other in size, form, and colour.

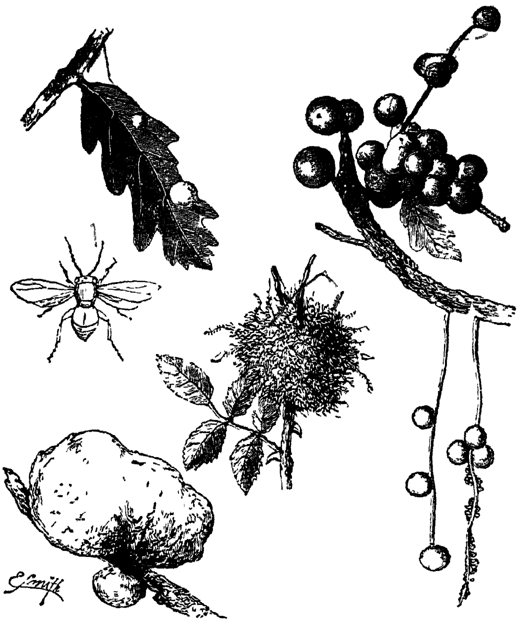
In the accompanying illustration are given several examples of British Galls, most of which are tolerably common in this country, and some of which can be found in plenty.

In the left hand upper corner of the illustration is a figure of an oak-leaf, upon which are two globular projections. These are the well-known "cherry-galls," which are made by a little insect. They are beautifully coloured, some being entirely scarlet, while others are white, orange, and red, in various gradations, something like the colour of a nearly ripe peach, or those of a Newtown pippin. Perhaps they bear more resemblance to the apple than to the peach, because their surface is highly polished and shining, much like that of the American apple.

These galls may be found in profusion upon the oak-leaves, and are most plentiful upon pollard oaks, upon the youngest trees, or upon the oak underwood that sprouts around a felled trunk. In such cases the leaves are much larger, and fuller of juice than those which spring from adult trees, and the development of the gall is proportionately increased. Wherever there is a thick growth of oaken underwood, the numberless galls which stud the leaves have a remark-

ably beautiful effect, provided that the observer lies on the ground, or stoops sufficiently low to perceive the under-surface of the leaves, to which the galls are attached.

If one of the galls be cut open with a knife, it



BRITISH GALLS.

Leaf Galls of Oak. Bedeguar of Rose Galls of Cynips Kollari
Cynips Kollari (slightly magnified). Currant Galls of Oak.
Oak Apple.

will be found to consist of a soft, pulpy substance, fuller of juice than an apple, and somewhat resembling the consistence of a hothouse grape. In the very centre of the soft mass the knife will meet with resistance in the shape of a globular cell of hard,

woody texture, and in the middle of the cell will be found a tiny grub, perfectly white, very fat, somewhat resembling the grub of the humble bee, and curved so as to fit the globular cell in which it lies. This is the little being for whose benefit the gall was formed, and the little white grub feeds on the juices of the gall, precisely as the larva of the ichneumon fly feeds on the soft portions of the insect in which it temporarily resides.

On seeing the little creature thus snugly ensconced in the receptacle which serves it at once for board and lodging, a question naturally arises as to the manner in which it was placed there. No aperture is perceptible in the gall, not a hole through which air can reach the enclosed larva, which must, therefore, be capable of existing without more air than can pass through the minute pores of the vegetable substance in which it lies, or must be able to respire by means of the oxygen which is given out by living plants.

The question, indeed, is very like the well-known query as to the manner in which a model of a waggon and four horses can find its way into a bottle, the neck of which is so small as to prevent even the head of the waggoner from passing. The answer is similar in both cases. The bottle was ingeniously blown over the waggon and horses, and the gall was formed around the grub.

When the leaf is in its full juiciness, and the sap is coursing freely through its textures, a little black insect comes and settles upon the leaf. She is scarcely as large as a garden ant, but has four powerful and handsome wings, which can be used with much agility. An entomologist, on seeing her, would at once pronounce

her to belong to the order hymenoptera, and to be closely allied to the ichneumon flies which have just been described.

Running to and fro upon the leaf, she fixes upon one of the nervures, and there remains for a short time, evidently busy about some task, which is very important to her, but which her minute size renders impossible to be observed with the naked eye. If, however, a magnifying glass be applied very carefully to the leaf, the following process will be seen.

From the abdomen there projects a tiny hair-like ovipositor, which is coiled in such a manner that it can be protruded to a considerable length. This ovipositor is thrust into the leaf, so as to produce a hole, which is widened by the action of the boring instrument. Presently, the blades of the ovipositor separate, and a single egg is seen to pass between them, so that it is lodged at the bottom of the hole. Into the same aperture is then poured a slight quantity of an irritating fluid, and the insect flies away, having completed her task. The whole proceeding, indeed, is, with the exception of the deposition of the egg, precisely the same as that which takes place when a wasp uses its sting, the ovipositor and sting being but two slightly different forms of the same organ, and the irritating fluid of the cynips being analogous to the poison of the wasp.

The effect of the wound is very remarkable. The irritating fluid which has been projected into the leaf has a singular effect upon its tissues, altering their nature, and developing them into cells filled with fluid. As long as the leaf continues to grow, the gall continues to swell, until it reaches its full size, which is necessarily variable, being dependent on that of the leaf. I have, for example, many specimens of these galls, of different sizes, from

which the insects have escaped, showing that they had attained their full size. On the juices of the gall the enclosed insect lives, until it reaches its full term of imprisonment, when it eats its way through the gall and emerges into the world. In some cases, it undergoes the whole of its change within the gall, but in others, it makes its way out while still in the larval state, burrows into the earth, and there changes into the pupal and perfect forms.

To the unassisted eye, the insect which forms the leaf-gall presents no especial attraction, as it is simply, to all appearance, a little black fly. When placed under the microscope, however, it soon proves to be a really beautiful creature, though not possessing the brilliant and gem-like hues which distinguish many of its relatives. The body still retains its blackness, but has a soft tint on account of the white and shining hairs with which it is thickly studded. The eyes are large, stand boldly from the head, and the many lenses of which these organs are composed are so boldly defined, that even in so small an insect they can be distinguished with a very low power of the microscope. Indeed, the inch and a half object glass is quite powerful enough to define them, while the half-inch glass makes them look like the pits in a lady's thimble.

The chief beauty of the insect, however, lies in the wings, which are very large in proportion to the size of the owner, are traversed by a few, but strong nervures, and glow with a changeful radiant lustre, like mother-of-pearl illuminated with living light. In order to see these wings properly, the insect should be laid on some black substance, and the light concentrated upon them by the various means which a microscopist can always employ.

The oak is a tree that seems to be especially loved by gall-insects, which deposit their eggs in its leaves, its twigs, its flowers, and even in its roots. One of the most familiar examples of oak-galls is that which is called the oak-apple, and which is produced by a species of insect called Cynips terminalis. Although the insect is not of very great size, the gall which it produces is sometimes enormous, being as large as a common golden pippin or nonpareil apple, and therefore very conspicuous upon the tree. It is coloured in the same manner as the cherry-gall, but seldom so brilliantly, and the exterior is not so smooth and polished.

The resemblance to a veritable fruit is much closer at the beginning of the season than in the autumn, as a number of small leaf-like projections surround its base, just as if they were a half-withered calyx. These, however, fall off as the summer advances, and are no more seen.

If the oak-apple be cut with a knife, the first touch of the steel betrays a marked difference between its substance and that of the cherry-gall. Its texture is neither so firm nor so juicy, but is of a softer, drier, and more woolly character. Moreover, the knife passes through several resisting substances, which, when the gall is quite severed, prove to be separate cells, each containing a grub. From each of these cells, which are extremely variable in number, a kind of fibre runs toward the base of the gall, and it is the opinion of some naturalists that these fibres are in fact the nervures of leaves which would have sprung from the bud in which the gall-fly has deposited her eggs, and which, in consequence of the irritating fluid injected into the tree, are obliged to develop themselves in a new manner.

To procure the insects of this and many other galls is

no very difficult task. The branch to which they adhere should be cut off, and placed in a bottle of water, and a piece of very fine gauze tied net-wise over it. The insects, although they can eat their way out of the gall in which they have been bred, never seem to think of subjecting the gauze to the same process, and therefore can be always secured. It is needful, however, to procure galls which are tolerably near their full age, as a branch can only be kept alive for a limited time, and if the supply of nourishment be cut off by the death of the branch, the enclosed insect becomes stunted, if not deformed.

The galls produced by Cynips terminalis are those which are so greatly in request upon the twenty-ninth of May, and which, when covered with gold-leaf, are the standards under which the country boys are in the habit of levying contributions. A figure of this gall is seen in the illustration.

Some years ago, when I was calling at the office of the *Field* newspaper, then recently started in its race for popularity, I was shown some oak-branches containing a vast number of hard, woody, spherical galls, and asked if I could tell the name of the insect which had produced them. They had recently made their appearance in the country, and no one knew anything about them. A branch beset with these galls is shown in the right hand upper corner of the illustration, the figures being necessarily much reduced.

I was totally unacquainted with them, but, in the following year, found many of them on Shooter's Hill, in Kent, where the growth of oaks is very dense. At the present day they have increased so rapidly that they outnumber almost every species, if we except the tiny spangle-galls,

and I have bred great quantities of the insect. The creature which made them is named *Cynips Kollari*, in honour of the celebrated entomologist, and is plentiful on the Continent. I believe that it has long been known in Devonshire, though in Kent it has only recently made its appearance.

The galls produced by this insect are wonderfully spherical, of a brown colour, smooth on the exterior, and about as large as white-heart cherries. Each contains a single insect, which undergoes all its changes within the gall, and eats its way out when it has attained the perfect form. Occasionally two galls become fused together, and in my collection there is a very curious example of these twin galls. They form a figure like that of a rude hour-glass, and each portion has contained an insect. The inhabitant of one portion has eaten its way out and escaped, but the other has met with a singular fate. By some untoward error, it has taken a wrong direction, and instead of issuing into the world in the ordinary way, has hit upon the neck which connects the two galls, so that, instead of merely piercing half the diameter of the gall, it would have been forced to gnaw a passage equal to three half diameters.

Natural powers are always adjusted to the work which their possessors have to perform. The insect was gifted with the capability of eating her way through the walls of her own habitation, but not with the power of making a passage through another gall afterwards. As a natural consequence, she has died from exhaustion before she could emerge into the air; and when I cut the double gall, in order to see how the inmates had fared, I found the dead insect lying near the middle of the second gall, so that she was even farther from the outer air that when she started on her course.

The Cynips Kollari is larger than the generality of the family, equalling a small house-fly in dimensions. Its colour is pale brown. A figure of the insect may be seen in the illustration.

Nearly in the centre of the illustration is seen a figure of the well-known gall that is so common on the rose, whether wild or cultivated, and which is popularly known by the name of BEDEGUAR. This gall is caused by a very tiny and very brilliantly-coloured insect, named *Cynips rosæ,* which selects the tender twigs of roses, and deposits its eggs upon them.

I have now before me quite a collection of these galls, some of which are so variable in shape that they scarcely seem to have been made by the same species of insect. When the Cynips rosæ deposits her eggs upon the rose, the effects are rather remarkable. Each egg becomes surrounded with its own cell or gall, and the whole of them become fused into one mass. The exterior of these galls is not smooth, like that of the specimens which have been described, but is covered with long, many-branched hairs, which stand out so thickly that they entirely conceal the form of the gall itself.

Reaumur, who gave much attention to galls, thought that the hairs were formed by the exudation of sap through little orifices in the growing gall, just as the web of the spider is formed by the exudation of a glutinous liquid from minute pores. This theory, however, is scarcely tenable, because sap has no power of hardening into threads when exposed to the air, and, besides, a well-defined vegetable structure is seen in the hairs, which would not be the case if they were merely hardened sap. Moreover, if the hairs were formed in this manner, they could not have the power of throwing out

the tiny branchlets with which they are studded, or of ramifying like the bough of a tree, as is often the case with them.

The number of galls in a single Bedeguar is mostly very great. A specimen of average size, taken at random from the drawer in which the galls are kept, was, when fully clothed, as large as a golden pippin. When the hairy clothing was removed, its size notably diminished, and it was then seen to be composed of a large number of woody tubercles, varying much in size and shape. Their average dimensions, however, are about equal to those of an ordinary pea. The tubercles in question are fused together more or less strongly, some falling off at a slight touch, while others cannot be separated without the use of the knife. There are about thirty-five of these wooden knobs.

On selecting one of the knobs, and examining it, a few very small circular holes are seen, showing that the insects have made their escape from the cells. Indeed, one or two of the insects were found entangled amid the dry and crisp hairs that surrounded the gall, and thus formed a second barrier, which they could not penetrate. When, however, a sharp knife is carefully used, the woody tubercle can be laid open in several directions, and then proves to be a congeries of cells fused together into one mass, and varying from four to twenty in number, according to the size of the insect. Perhaps, on an average, ten cells may be reckoned in each knob.

In many of the cells the perfect insect may be found, the death of the rose-branch, and the consequent deprivation of sap, having so hardened the walls of the cells that the inmates have been unable to make their way out. In other cells may be seen certain odd little objects,

amber-coloured, hard, shining, and appearing to the unaided eye to be nearly spherical. They are about as large as dust-shot. For a long time I could not satisfy myself about them, not being able clearly to ascertain whether they were deceased insects or merely hardened sap. That they were probably of insect origin was evident from the fact that they were always found in cells which had no opening, and from which the insect had not escaped.

At last, however, one of them happened to lie on the paper so that it could be well illuminated, and then the whole mystery was unfolded. These strange little objects were the pupæ of the insects, which had died in the cells, and shrivelled up into the singular forms which have been described.

The cells are of different sizes, some being more than ten times as large as others. The superior dimensions of the cell seem to be obtained at the expense of the walls, so that the large cells can be broken by the finger and thumb, while the small cells cannot be opened without the knife.

The insects themselves are equally variable, some being mere dots of shining blue and green, while others are about as large as the common red ant of the gardens, but with plumper bodies. In consequence of these two facts, the large, strong-jawed insect can easily make its way through the comparatively thin walls of the large cell in which it was enclosed, while the small and necessarily weak-jawed specimens are utterly unable to pierce the walls of their cells, which are so thick that they must bore a hole equal in length to that of their whole body before they can escape into the air. Consequently the great mass of the insects that are found in the cells are the small specimens, the larger having made their

escape. I find that on an average twenty small insects are thus found in proportion to one of the larger kind.

Nothing is easier than the rearing of insects from this as well as other galls, but to decide upon the species which make them is by no means so easy a task as appears on the surface. Even should the experimenter find the right species of insect in the gauze bag, he has to go through the wearisome task of searching through the family of Cynipidæ, and identifying the species—a process which every entomologist is rather apt to postpone until the visionary period when he shall have leisure.

But it is very probable that the required insect does not make its appearance at all, and that the little hymenoptera which make their way out of the cells, or are found dead within them, are not the rightful occupants of the galls. For the Cynipidæ are as liable to parasites as other insects, and it frequently happens that from a single many-chambered gall will issue insects that sadly puzzle an amateur, as they seem to belong to at least two distinct species. The very gall which has just been described affords a good example of this fact, for in some of the chambers are specimens of the true *Cynips rosæ*, and in others are insects which belong to another family, the Ichneumonidæ, which, as the reader may remember, are parasites upon other insects. They have evidently introduced their eggs into the cells occupied by the larvæ of *Cynips rosæ*, so that the larvæ which have been hatched from these eggs have fed upon the legitimate occupants, and come to maturity in the cells that were designed for others.

Insects of totally different orders sometimes make their appearance. When I began to take to pieces the gall which has been described, I was rather surprised to find among the long hairs an empty cocoon of the Galleria

moth, whose ravages have been mentioned in an earlier part of the volume. On further dissecting the gall, no less than twelve other cocoons were found, all buried so deeply in the hairs and among the woody cells that they could not be seen until the hairy clothing was removed. A person who was entirely ignorant of entomology might naturally fancy that the moths were the architects of the gall from which they had apparently issued. How they obtained access to the galls, and on what food they lived, are two problems that I can by no means solve. The drawer in which the galls were placed is tightly closed, and all bee, wasp, and hornet combs have been so treated with corrosive sublimate, that they have not been touched by the caterpillars from which the moths had been developed.

There is another gall, very common in England, which is found upon the oak, and which is generally thought, by persons who are unacquainted with botany or entomology, to be the bud which naturally grows upon the tree.

In these curious galls, the excrescences with which they are covered take the form of leaves instead of hairs, as is the case with the bedeguar and many other galls. These bud-like objects may be found on the young twigs, and may be easily recognised by their shape, which somewhat resembles that of a pine-apple, and the curious manner in which their leafy covering lies regularly over them, like the tiles upon an ornamental roof. The size of the gall is rather variable, but it is, on an average, about as large as an ordinary hazel-nut.

The gall is so wonderfully bud-like that I have known the two objects to be confounded—the immature acorns in their cups to be carried off as galls, while the real

galls were left on the tree. The incipient naturalist who made the mistake kept the buds for some eighteen months, and was sadly disappointed to find that no insects were produced from them.

The insect whose acrid injection produces this curious effect upon the tree is rather larger than the leaf-gall insect, and is of more slender proportions. It has been suggested that the object of the leafy or hairy covering is, that the insect, which remains in the gall throughout the winter, should have a warm house by which it may be protected from the chilling frost as well as from the wind and rain.

If the reader will again refer to the illustration, he will see that from the same branch on which the *Cynips Kollari* has formed so many galls, depend two slender threads supporting one or two globular objects. These are popularly called CURRANT-GALLS, because they look very much like bunches of currants from which the greater part of the fruit has been removed. Their colour, too, is another reason for giving them this name, as they are sometimes scarlet, resembling red currants, and sometimes pale cream colour, thus imitating the white variety.

These galls are placed upon the catkins of the oak, which are forced to give all their juices to the increase of the gall, instead of employing them on their own development. Some authors think that the insect which forms them is a distinct species, while others think that the galls are the production of the same insect which forms the leaf-gall, the punctures being made in the stalk of the catkin and not in the nervure of the leaf.

That this supposition may be correct is evident from the fact that the same insect which forms the oak-apples does also deposit its eggs in the root of the same tree,

causing large excrescences to spring therefrom, each excrescence being filled with insects. I have often obtained these root-galls, several of which are now before me, some having been cut open, in order to show the numerous cells with which they are filled, and others left untouched, in order to exhibit the form of the exterior. Being nourished by the juices of the root, they partake of the sombre hues which characterise the part of the tree from which they spring, and do not display any of the colours which are seen on the oak-apples which spring from the twigs.

There are, however, distinct species of gall insects which pierce the roots of the oak-tree. One of them is termed *Cynips aptera*, and makes a pear-shaped gall about one-third of an inch in diameter. Each gall contains a single insect, and a number of the galls are often found attached by their narrow end to the root-twigs of the tree, something like a bunch of nuts on a branch. There is another insect which forms a many-chambered gall of enormous size, containing a small army of insects. Mr. Westwood mentions that one of these galls in his possession was five inches long, one inch and a quarter wide, and produced eleven hundred insects, so that the entire number was probably fourteen or fifteen hundred.

No one who is accustomed to notice the objects which immediately surround him can have failed to observe the curious little galls which stud the leaves of several trees, and which are appropriately called SPANGLE-GALLS, because they are as circular, and nearly as flat, as metallic spangles.

These objects had been observed for many years, but no one knew precisely whether their growth was due to animal or vegetable agency. That their substance was vegetable was a fact easily settled, but some botanists

thought that they were merely a kind of fungus or lichen, while others supposed that they were the work of some parasitic insect.

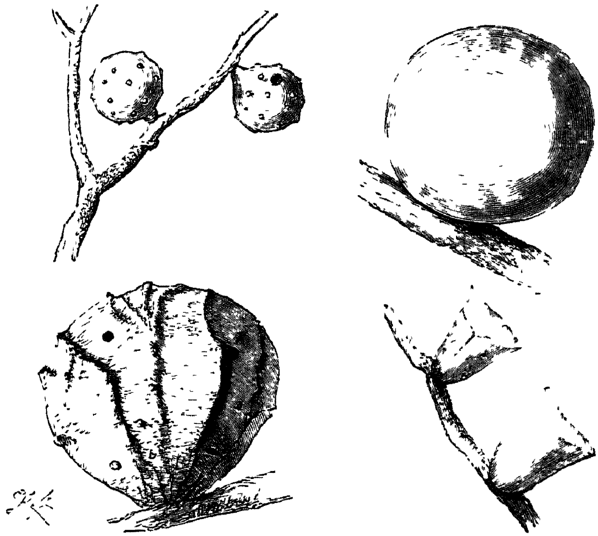
When closely examined, these "spangles" are seen to be discs, very nearly but not quite flat, fastened to the leaf by a very small and short central footstalk. Reaumur set at rest the question of their origin by discovering beneath each of them the larva of some minute insect, but he could not ascertain the insect into which the larva would in process of time be developed. The task of rearing the perfect insect from the gall is exceedingly difficult, the minuteness of the species and the peculiar manner in which the development takes place, being two obstacles which require a vast expenditure of care and patience before they can be overcome.

Supposing a branch containing a number of infested leaves to be placed in water and surrounded with gauze, it will die in a week or two, and yet there will be no sign of an insect. If the branch be kept until the winter has fully set in, the desired insects will still be absent, and the experimenter will probably think that his trouble has been thrown away. The real fact is, that the little insects are not developed until the spring of the following year, and that they pass through their stages of the pupal and perfect forms after the leaves have fallen, and while they are still lying on the ground.

We now pass from the British galls to those which are found in various other countries. A few of the more interesting examples are figured in the accompanying illustration.

Should the reader have the curiosity to examine for himself the structure of the British galls (as I trust he will do), he will find that when he cuts a juicy specimen,

such as that of the leaf-gall, his fingers will presently be stained with purple-black. He may wash his hands as much as he likes, but he will not wash away the stain, which soon looks as if it had been produced by spilling ink on the hands. There is reason for such an appearance, inasmuch as the staining liquid is really ink, though of a paler hue than that which is used for writing.



FOREIGN GALLS.

Ink Galls. Dead Sea Apple

Hungarian Gall. Galls of Cynips polycera

A little lemon-juice will soon discharge the colour, and then the soap and water will remove the last remnants of the stain.

Ink is made by mixing a solution of the sulphate of iron (properly called green vitriol or copperas) with a decoction of certain oak-galls. Perhaps I may mention that a "decoction" signifies water in which any sub-

stance has been submitted to boiling heat, but not dissolved. Tea, for example, is, when properly made, a decoction of the leaf, though when made with hot, but not boiling water, it has no right to the name. The solution of copperas is only pale green, and that of the gall is nearly colourless, although when mixed, they become deeply black. The old practical joke of forcing a dupe to stain his hands and face black, depended on the knowledge of these properties.

Before the victim went to wash his hands, some of the decoction of galls was poured into the water, while the towel with which he was supplied had been damped with the copperas solution and then dried. The consequence of this combination was, that although the hands and face might be washed perfectly clean, yet as soon as they were dried with the prepared towel the union of the two substances produced ink, and both hands and face were deeply stained.

Now when a gall is cut with a knife, the slightly acid juice acts upon the steel, and so a kind of ink is produced, which is pale, but still a veritable ink. There is a well-known method of secret writing which depends on this property of iron and tannin, the principle contained in the galls.

A quill pen is dipped in the solution of copperas, and the required message is written, usually between the lines or among the words of a letter on unimportant subjects, so as to avoid the suspicions which would be aroused by a sheet of blank paper. The almost colourless solution leaves no mark, and the letter passes without comment, until it reaches the person who is in the secret. He pours some decoction of galls into a wide and flat vessel, and warily dips the letter into it, so as to wet it; or he saturates a cloth with the decoction, and lays the

letter upon it. The tannin then acts upon the solution of iron, ink is formed by their combination, and the formerly invisible words immediately become plain and legible.

A decoction of oak-bark would make ink, though of inferior quality, and so would tea, inasmuch as the tea-leaf contains a large amount of tannin. In fact, whenever the ink in the bottle becomes thick, it can always be restored by adding to it a little strong tea, which not only gives the requisite liquidity, but does so without affecting the blackness, which would probably be the case if simple water were added.

The two principal ingredients of the ink which is in common use are sulphate of iron and the galls of a species of oak which grows in large quantities in the Levant. They are technically termed Aleppo galls, and are divided into several classes, according to their value. Besides these two ingredients a little gum is added, in order to give consistency, and a very little corrosive sublimate or creosote, to prevent the growth of mould. The proportions are generally six ounces of pounded galls, four ounces of copperas, and four ounces of gum arabic to six pints of water.

In the upper left hand corner of the illustration two of these galls are seen upon a branch of the oak.

They are necessarily much reduced in size, their ordinary dimensions being about equal to those of *Cynips Kollari*. For the purposes of trade they are divided into black, blue, green, and white galls. The last-mentioned class of galls includes those from which the insects have escaped, and which are consequently weakened in astringency. They are so called because they assume a paler hue than the three first classes, in which the insect still remains. In shape, the ink-gall is nearly spherical, with a slight tendency to a

pear-like form, and their exterior is defended by a few short, stout, and rather sharp prickles.

I cannot but think that the gall-insect affords a proof that the most insignificant objects of creation have their uses, provided that we could only discover them. Nature is a vast treasure-house, or rather a city of treasure-houses, very few of which have been unlocked, because no one has found the keys. No one indeed is likely to do so, as long as he chooses to despise "little things," and if the only acknowledged benefit conferred on mankind by the insect tribes had been the ink-gall, it is a boon so great that every insect ought to deserve our respect as the possible donor of some similar aid to civilisation at present unknown.

In the right hand upper corner of the illustration is seen a gall of some size, and nearly spherical. This is the celebrated DEAD SEA APPLE, of which such strange stories have been told.

This so-called fruit was said to be lovely and beautiful to the eye, but, instead of containing sweet juice, to be filled with bitter ashes, which filled the mouth as soon as it was bitten. Of course, the ashes were supposed to be drawn by the tree from the sunken remnants of the three evil cities beneath the bituminous waves of the Dead Sea, and to present tangible evidence of their existence.

This story, which was implicitly believed for many centuries, was at length as decidedly discredited, and the whole narrative of the ash-filled fruit denounced as a mere fable. However, recent researches have proved, as is often the case, that the main facts of the story are true, though the inference to be derived from them has been entirely mistaken. In the first place, these seeming fruits are not produced by any

of those trees which are known to gardeners as fruit-bearers, but are found only upon a species of oak, which is in fact the same tree that furnishes the ink-galls of commerce. At the proper season of the year, the oaks, which are of low stature, and more like scrubby bushes than the stately trees which are suggested by the name of oak, are seen to be covered with round, fruit-looking objects, beautifully coloured, and closely resembling ripe apples. If, however, they are cut open, they will be found to be the habitation of a species of gall-fly.

It is evident that if any one were to bite a gall, especially one that was produced from the oak, the exceedingly astringent properties of the excrescence would produce a very rough and ash-like sensation to the palate, which would be increased by the dryness of its substance. Except in size, they much resemble the gall of commerce, and many persons have thought that they are produced by the same insect.

Immediately below the Dead Sea Apple, and in the right hand lower corner, may be seen two remarkable objects, which would scarcely be recognised as galls except by an experienced eye. They are, however, the production of an insect called by entomologists *Cynips polycera*.

These galls are found in many parts of Germany, upon the oak-tree, and are at once recognised by their remarkable form. As may be seen by reference to the illustration, they are shaped something like miniature sugar-loaves, and stand boldly from the branch with their broad end uppermost. The body of the gall is slightly conical, so that if cut transversely, it would present a circular section. The end, however, is constructed after a peculiar fashion.

It is nearly flat, "abruptly truncated" according to scientific language, and throws out several projections like horns or spines. The reader will remember that the ink-gall also possesses short and sharp projections, but they start from all parts of the surface, whereas in the present species they belong wholly to the flattened end. Their number is variable, so that the end of the gall is sometimes triangular and sometimes squared, besides assuming other forms according to the number of projections. This remarkable form has earned for the insect the name of *polycera*, this term being derived from two Greek words which signify "many-horned." The insect which forms this curious gall is about half as large as *Cynips Kollari.*

The last example which is represented in the illustration is also found in Germany upon the oak, and is made by an insect which is called *Cynips Hungarica.*

This gall is represented of the natural size, whereas all the others are much diminished, in order to be inserted in so limited a space. It is a very remarkable object, and cannot be mistaken for any other species. Its surface is traversed by a variable number of irregular ridges, which all radiate from the stem, and so pass longitudinally over the gall. The whole of the ridges are rough and sharp-edged, but at intervals they shoot out into hard-pointed horns, much like those which arm the preceding species. Indeed, the whole substance of the gall is remarkable for its hard texture, for when cut with a knife it offers as stubborn a resistance as if it were seasoned oak or elm.

That a hymenopterous insect should be able to bore its way through so hard a substance, and to make a tunnel barely wide enough for the passage of its body,

and nearly three-quarters of an inch in length, is really surprising. The insect is not a large one, and resembles *Cynips Kollari* so closely that an inexperienced observer would certainly mistake it for that insect, the distinctions being so trifling that they can only be detected by means of the microscope.

CHAPTER VI.

PARASITIC NESTS—(continued).

The Oak-tree and its aptitude for nourishing Galls—Compound Galls, or one Gall within another—The SENSITIVE GALL of Carolina—The fungus of wine-vaults—Galls and the insects which caused them—Colours of Galls—Whence derived—The Galls of various trees and plants—The Cynips parasites upon an insect—Galls produced by other insects—Mr. Rennie's account of the BEETLE GALL of the Hawthorn—The BEETLE GALL of the Thistle—DIPTEROUS GALL-MAKERS—Leaf-miners and Galls—Size of the larvæ of Leaf-miners—The perfect insect and their beauty—Method of displaying the insect—SOCIAL LEAF-MINERS—DIPTEROUS LEAF-MINERS—Animal Galls—The CHIGOE and its habits—Its curious egg-sac—Difficulty of extirpating it—The penalty of negligence—The BREEZE FLIES and their habitations—WURBLES and their origin—Their influence upon cattle—The CLERUS and its ravages among the hives—The DRILUS—Its remarkable form and the difference between the sexes—The curious habitation which it makes.

THE reader cannot but notice the singular aptitude possessed by the oak-tree for nourishing galls. No part of the tree seems to escape the presence of a gall of some sort, diverting its vital powers into other channels. The tree, however, does not appear to suffer from them, and it is just possible that they may be useful to it. The leaves are studded with galls, and so are their stems. The branches are covered with galls of various shapes, sizes, and colours, some bright, smooth, and softly coloured, like ripe fruit, others hard, harsh, spiny, and rough, as if the very essence of the gnarled branches had

been concentrated in them. There are galls upon the flowers, galls upon the trunk, and even galls upon the root.

Some oak-galls may be called compound galls. M. Bosc mentions a small gall which is found upon the American oak. It is not larger than a pea, and if shaken is found to contain some hard substance loosely lodged in its interior. When the gall is cut open, a very curious state of things is seen. The walls are very thin, so that, in spite of the small dimensions, the cell is larger than that of many cynipidæ. Within the cell, no insect is discovered, but in its place a little spherical object, about as large as a No. 5 shot, which is very hard, and rolls about freely in the interior. If this be opened, the larva is found within it, reminding the adept in fairy lore of the white cat whose gifts were enclosed in a succession of nuts, each within the other. How these singular little cellules are made is not known, though their discoverer expended great trouble and patience upon them.

The same naturalist mentions another species of gall, also found upon the oak in Carolina. It is spherical, covered with prickles like a thistle, and beset with a thick downy covering of rather long hair. Many other galls possess these characteristics, but the most curious point connected with this species is, that the hairs are as mobile as those of the sensitive plant, and as soon as they are touched, sink down, and never afterwards regain their former position.

There is a kind of fungus which is found in wine-vaults, and which exhibits a similar phenomenon. When newly grown, it hangs in great masses, like tufts of pure cotton-wool. But to carry a specimen away is impossible, for, as soon as it is touched, it begins to con-

tract, and in a minute or two shrivels up into a flat membraneous mass, that looks like the web of the house-spider. M. Bosc was unable to rear any of the inmates of these galls.

The size of a gall is no criterion of the dimensions or numbers of the insect which made it. Even in the galls which infest the oak, the smallest galls often furnish the largest insects, and in some specimens brought from Greece, the gall is as large as an ordinary black-currant, while the cell would contain a red-currant, showing that the inhabitant of the cell must be a large one in order to fill it. Again, although the oak-apple and rose-bedeguar do contain a great number of insects, there are many examples where galls scarcely so large as a pea contain from ten to fifteen insects, while the ink-gall and the large Hungarian gall are inhabited by a single insect.

One of the most curious problems is, to my mind, that of the brilliant colours with which many of these galls are decorated. That the rose-bedeguar should be so beautifully adorned with scarlet and green is a fact which does not seem to excite any astonishment, inasmuch as it may be said that the colours which ought to have been developed in the petals and the leaves have been diverted from their proper course, and forced to exhibit themselves in the gall.

Botanists and physiologists will see that this idea is quite groundless, but to the uninstructed and popular mind it has a sort of plausibility that often commands assent. But when we come to the oak-tree the case is at once altered, and some other cause must be found for the lovely colours of its galls. The cherry-galls are as brightly coloured as any apple, and the soft hues of the

oak-apple are nearly as beautiful though not so brilliant. Yet the oak possesses no such storehouse of colour as is popularly attributed to the rose. Its leaves are simple green, and its flowerets are so colourless as scarcely to be distinguished by the unassisted eye.

Whence then are derived these beautiful colours? Some hasty observers, who have neglected the first rule of logic, and drawn an universal conclusion from particular premises, have said that the colours of the gall are derived from the insect; adducing, as a proof of their assertion, the brilliant colours which equally deck the rose-bedeguar and the *Cynips rosæ* from which it sprang. But if they had only followed the example of careful naturalists, who, like Dr. Hammerschmidt, have examined and drawn between two and three hundred species of galls, so hasty a generalisation would never have been made. The cherry or leaf-gall of the oak is every whit as gorgeously coloured as the bedeguar of the rose, while the insect that made it is quite black. It is true that the diaphanous wings glitter as if they were made of polished gems; but this appearance is due, not to the wings themselves, but to the myriad hairs with which they are regularly studded, each hair acting as a miniature prism by which the light is refracted and broken into the resplendent hues of the rainbow.

Many other trees beside the oak are chosen by certain species of gall-fly, and even the herbs and flowers do not escape the ravages of these remarkable insects. The white poppy, from which is obtained the opium of commerce, is attacked by a species of gall-fly, which lays its eggs in the large head, or pod, and sometimes does much damage to the plant, the delicate divisions between the seed vessels being rendered quite hard and solid, and the

pod itself deformed. Mr. Westwood has described a species of gall-fly which infests the turnips, and another species is known to lay its eggs upon wheat.

As if to show that the family of Cynipidæ is really related to the ichneumons, it has been discovered that some species of this family are actually parasitic upon other insects. In treating of this remarkable fact, Mr. Westwood writes as follows:—"The relations of these insects with the following families (*i.e.*, Evanidæ and Ichneumonidæ) have been already noticed. It had always appeared to me contrary to nature that a tribe of vegetable-feeding insects should be arranged in the midst of parasites; nor was it until I had an opportunity of ascertaining the parasitic habits of some of the species of the family, that I was enabled to form a just notion as to the true value of the parasitic or herbivorous nature of these insects. In June 1833, I detected a minute species, *Allotria victrix*, in the act of ovipositing in the body of a rose-aphis, and I subsequently succeeded in hatching specimens of the perfect insect from infested aphides."

A figure of the tiny insect is given, as it appeared while in the act of depositing its eggs, and has a rather remarkable effect, from the fact that the very minute dimensions of the parasite make the aphis look quite a large insect. Other species of this family are also known to be parasitic. The rose-aphis is certainly infested by two species of gall-fly, and probably by more, while the aphides which are found on the willow, the cow-parsnip, and other plants, also fall victims to the Cynipidæ. There is one genus of this family, called *Figites*, which is parasitic on the larva or pupa of certain dipterous insects.

The Cynipidæ are not the only insects that produce

galls upon different plants. For example, several species of beetle are known to pass their earlier stages in swellings produced by the puncture of the parent insect. There is a little weevil of a greyish brown, which is mentioned by Mr. Rennie as forming a gall upon the hawthorn.

"In May 1829, we found on a hawthorn at Lee, in Kent, the leaves at the extremity of a branch neatly folded up in a bundle, but not quite so closely as is usual in the case of leaf-rolling caterpillars. On opening them up, there was no caterpillar to be seen, the centre being occupied with a roundish, brown-coloured, woody substance, similar to some excrescences made by gall insects (*Cynips*).

"Had we been aware of its real nature, we should have put it immediately under a glass, or in a box, till the contained insect had developed itself; but instead of this, we opened the ball, where we found a small yellow grub coiled up, and feeding on the exuding juices of the tree. As we could not replace the grub in its cell, part of the wall of which we had unfortunately broken, we put it in a small pasteboard-box with a fresh shoot of hawthorn, expecting that it might construct a fresh cell. This, however, it was probably incompetent to perform; it did not, at least, make the attempt, and neither did it seem to feed on the fresh branch, keeping in preference to the ruins of its former cell.

"To our great surprise, although it was thus exposed to the air, and deprived of a considerable portion of its nourishment, both from the fact of the cell having been broken off, and from the juices of the branch having been dried up, the insect went through its regular changes, and appeared in the form of a small greyish brown beetle of the weevil family.

"The most remarkable circumstance in the case in question, was the apparent inability of the grub to construct a fresh cell after the first was injured,—proving, we think, beyond a doubt, that it is the puncture made by the parent insect when the egg is deposited that causes the exudation and subsequent concretion of the juices forming the gall." Although the insect in question succeeded in attaining the perfect state, it would probably be of stunted growth in consequence of the deprivation of food. Such, at all events, is the case with insects of other orders, when their supply of food is at all checked while they are in the larval state.

There is another weevil which is one of the gall-makers. It is one of the largest of the British weevils, being more than half an inch in length, and is very simply clad in grey and black.

If the reader desires to discover the larva of the beetle he may probably be successful by going to any waste spot where thistles are allowed to grow, and examining them carefully about the stems and roots. Nothing is more common than to find the stems of thistles swollen in parts, and in many cases the root is affected as well as the stem. Fortunately for the gardener, who hates thistles, even though he should be a Scotchman, as is so often the case with skilled gardeners, the larva of the Cleonus feeds on the juices of the plant at the expense of its life, so that the thistle dies just before the seed is developed, and a further extension of the plant is thereby prevented.

There are also gall-making insects among the Diptera. Such, for example, is the THISTLE-GALL FLY, which produces large and hard woody galls upon the thistle, as

well as several species of the larger genus Tephritis, some species of which live in the parts of fructification of several flowers, the common dandelion being infested by them.

We may now describe, at fuller length than has hitherto been done, another group of insects, which live between the membranes of leaves, and which belong to different orders.

LEAF-MINERS AND ROLLERS.

If the reader will carefully examine the leaves of any rose-tree which grows in the open air, he will certainly remark that many of them are notable for certain curious markings, which look something like the rivers in a map, and which traverse the leaf in various ways. They all, however, agree in one point, namely, their gradual and

regular increase in diameter. At their origin, they are so small that the finest thread could hardly pass through them, but in proportion as they increase in length they increase in width, so that at their termination they are sometimes the twelfth of an inch in width.

These marks are the tracks made by very small larvæ, which live between the membranes of the leaves, and feed upon the parenchyma, or soft substance which lies between the two membranes. They follow no rule in their meanderings, but traverse the leaf in a variety of ways. Sometimes they never leave the edge, but follow every little serration of the leaf with perfect accuracy. Sometimes they form a kind of spiral, and sometimes they wander irregularly over the whole leaf. Generally, the insect does not cross the track which it has once made, being diverted from doing so by some wonderful instinct. There are instances, however, where the insect has crossed its own track, not only once, but several times.

If the little gallery be opened at the widest extremity, one of three things will be found. Sometimes there is a tiny white grub, very much resembling the larva of certain beetles, and having the rings which represent the thorax rather wider than those which will afterwards be developed into the abdomen. As the little creature is able to live between the membranes of a leaf so thin as that of the rose or oak, it is evident, to the most superficial observer, that the insect which will be developed from it must be of very minute dimensions.

The larva of all winged insects is very large in proportion to the same insects when they have obtained their perfect form, much of the substance being taken up by the wings. As a natural consequence, it follows that the larger the wings, the larger must be the grub,

the size of the body being quite a secondary consideration. In the presen case, the larvæ which we are supposed to examine belong to the lepidopterous order, in all of which insects the wings, when present at all, are of great comparative size. If, then, the full-grown larva is so small that it can lie concealed between the membranes of a leaf without causing any conspicuous alteration in its outline, it is evident that the perfect insect must be of almost microscopical minuteness. Accordingly, it has been found that the little moths which have been bred from such caterpillars are so small that they have almost escaped observation until comparatively late years.

How small these insects are may be imagined from the fact that many species of the *Microlepidoptera*, as they are fitly named, do not occupy, even with their wings spread, a space larger than is taken up by the capital letter at the beginning of this sentence. To "set" these tiny creatures is necessarily an extremely difficult task, and cannot be accomplished by the ordinary plan of running a pin through the thorax, and extending the wings on the "setting-board." The only method of displaying them is to set them on white cardboard by means of gum, which is strengthened by many entomologists with various substances. A sheet of cardboard covered with specimens of Microlepidoptera neatly set is a very pretty sight, but needs the aid of the microscope before it can be perfectly seen.

Even to the unaided eye, the tiny moths are seen to be beautifully decorated, their wings gleaming in favourable lights like the throat of the humming-bird. But when placed under the microscope, especially if it be furnished with a binocular tube, and illuminated by a suitable light, the wings are positively dazzling in their

brightness, and hues that formerly seemed to be but dun and bronze or brown, suddenly flash out into gold and emerald, each scale distinct and shining, as if of burnished metal.

Sometimes, when opening the extremity of the leafy tunnel, we find a tiny chrysalis lying in the little chamber, and awaiting the time for the shell to burst and the perfect insect to emerge. Later in the year, we shall find neither larva nor pupa, but shall see a little hole in the leafy chamber, from which issues the shattered end of an empty chrysalis-shell, showing that the moth has made its escape into the outer air.

Two examples of other mined leaves may be seen upon the illustration, both drawn from the actual object. The specimen in the right-hand upper corner was taken from the bramble, and has been mined by the larva of a little moth called *Nepticula anomella*. It is a very pretty little creature, though its hues are not brilliant without the aid of the microscope. The upper wings are brown, but their tips are beautifully coloured with bright chestnut. The lower wings are pale grey, without any of the brilliancy that distinguishes the upper pair. They possess, however, a compensating beauty in the long, feathery fringe with which they are edged, and which, when subjected to the microscope, is seen to consist of the ordinary scales of the wings exceedingly developed both in length and width.

The leaves on the left hand were taken from the garden-rose, and have been mined by the larva of another species of the same genus.

This beautiful little moth derives its specific name from the peculiar colouring of the upper wings, which are bright chestnut, relieved by a broad band of gold across their centre. The tips of these wings are fringed,

and the lower pair are nearly white, and edged with a fringe similar to that which has already been described.

As a general rule, the leaf-mining caterpillars are solitary; and if even two or three are found in the same leaf, each leads an isolated life, and does not inhabit the same burrow as its neighbour. There are, however, exceptions to this rule, as to most others, and certain species of leaf-miners inhabiting the henbane, live harmoniously together between the membranes of the same leaf. They are larger than the ordinary species, and are remarkable for their power of burrowing into a fresh leaf when ejected from their former habitation, a power which does not seem to belong to the caterpillars of the Microlepidoptera.

Although the greater number of these insects belong to the lepidoptera, the rule is by no means an universal one. Many beetles are thus parasitic within the leaves of plants, and, as a general rule, they belong to the family of Curculionidæ, or weevils. There are also several species of dipterous insects which have this habit, among which may be named the CHRYSANTHEMUM FLY, which burrows into the leaves of the flower. There is also a genus of flies called Phytomyza, *i.e.*, Plant-sucker, the different species of which select particular plants and burrow between the membranes of their leaves. The holly, for example, is infested by one species, the honeysuckle by another, and the common heart's tongue by a third.

We must now glance at a few of the insects that are parasitic upon other animals. Their numbers are very great, but we must restrict ourselves to those which construct some sort of a habitation.

The only insect which can be said to be parasitic on man, and at the same time to form a habitation, is the celebrated CHIGOE, otherwise called the JIGGER, or EARTH FLY. This terrible pest is a native of Southern America and the West Indian Islands, and is too well known, especially by the negroes and natives.

This insect, which is closely allied to the common flea, and much resembles it in general appearance, contrives to hide itself under the nails of the fingers or toes, usually the latter. Having gained this point of vantage, it proceeds very gradually to make its way under the skin, and, strange to say, does so without causing any pain. There is a slight irritation, rather pleasing than otherwise, to which a novice pays no attention, but which puts an experienced person on his guard at once.

The male Chigoe is innocent of causing any direct injury to man, the female being the cause of all the mischief. As soon as she is settled, her abdomen begins to swell until it becomes quite globular, and of great comparative size, and containing a vast quantity of tiny eggs. Pain is now felt by the victim, who generally has recourse to the skilful old dames, who have a kind of monopoly of extracting Chigoe "nests." With a needle, they carefully work round the globular body of the buried insect, taking great care not to break it, as, if a single egg remains in the wound, all the trouble is wasted. By degrees they gently eject the intruder, and exhibit the unbroken sac of eggs with great glee. To prevent accidents, however, the wound is filled with a little Scotch snuff, which certainly causes rather a sharp smarting sensation, but effectually destroys any egg or young insect that may perchance have escaped notice.

Europeans and natives of the better caste escape easily enough, because they always take warning by the first

intimation of a Chigoe's attack, and generally succeed in killing her before she has succeeded in burying herself. Moreover, the shoes and stockings of civilised man protect his feet, and the gloves guard his hands, so that the insect does not find many opportunities of attacking the white man.

But the negroes, and especially the children, suffer terribly from the Chigoe. Children never are very apt at sacrificing the present to the future, and the negro child is perhaps in this particular the least apt of all humanity. The Chigoe is in consequence seldom disturbed until it has made good its entrance, and even then would not be mentioned by the child, on account of the pain which he knows is in store for him. But the experienced eyes of the matrons are constantly directed to the feet of their children, and if one of them is seen to hold his toes off the ground as he walks, he is immediately captured and carried off to the operator, uttering dismal yells of apprehension.

He certainly has good reason for his fears. The Chigoe nest is duly removed, and then, partly to prevent the hatching of any egg that may have escaped during the operation, and partly to punish the delinquent for his disobedience, the hollow is filled, not with snuff (which is too valuable a substance to be wasted), but with pounded capsicum. The discipline is certainly severe, but it is necessary. After a child has once paid the penalty of negligence, he seldom chooses to bring such a punishment on himself a second time, and as soon as he feels the first movements of a Chigoe, away he goes to have it removed before it can burrow under the skin.

If the Chigoe be allowed to remain, the results are disastrous. Swellings make their appearance along the

limbs, the glands become affected, and if the cause is permitted to remain undisturbed, mortification takes place, and the sufferer dies. So the red-pepper discipline, severe as it may be, is an absolute necessity with those who are unable to reason rightly, or to exercise forethought for the future. Every evening the negro quarter of the villages is rendered inharmonious by the outcries of the children who have neglected to report themselves in proper time, and who in consequence are suffering the penalty of their negligence.

There are some insects which produce upon animals certain swellings which are analogous to the galls upon trees. Such, for example, is the well-known BREEZE FLY, which is so troublesome to cattle. The larvæ of this insect live under the skin of the animal, and in some manner raise a large swelling, that is always filled with a secretion on which they live. In fact, the swelling is a gall produced on an animal instead of a plant, and the enclosed insect feeds in a similar manner upon the abnormal secretion which is induced by the irritation of its presence.

The larvæ are fat, soft, oval-bodied creatures, and are notable for the flattened end of the tail, on which are placed two large spiracles or breathing-holes.

Although the larva which inhabits the vegetable gall seems to have but small need of air, and to all appearance can exist without any apparent channel of communication with the external atmosphere, such is not the case with the inhabitant of the animal gall. An opening is always preserved in the upper part of the swelling, and the tail of the grub is tightly pressed against the aperture so as to ensure a constant supply of air.

In the months of May and June, these swellings may be found in great plenty. They are mostly seen upon young cattle, and as a general rule are situated close to the spine. So common indeed are they, that out of a whole farm-stock of cattle I have seen almost every cow under the age of four years attacked by the Breeze Fly, and counted from two or three to twelve or fourteen upon a single animal. It is said that as many as forty have been detected upon a single cow, but such an event has not come within my own observation.

The swellings caused by the Breeze Fly are called Wurbles, or Wornils, and can be easily detected by passing the hand along the back. Strangely enough, the cow does not appear to feel any pain from the presence of these large parasites, nor does she suffer in condition from them, although it would seem that they must keep up a continual drain upon the system. Indeed, some experienced persons have thought that, instead of being injurious, they are absolutely beneficial.

When the grub has reached its full development, it pushes itself backwards out of the gall, and falls to the ground, into which it burrows. Presently, the skin of the pupa becomes separated from that of the larva, and the latter dies, and becomes the habitation in which the pupa lives. The head portion of the skin is so formed that it flattens when dry, and can easily be pushed off, like the lid of a box, permitting the perfect fly to escape. Even when the insect is still in its pupal condition this lid can be removed, so that the pupa can be seen within its curious habitation. I may mention here that insects which are thus covered while in their pupal state, so as to show no traces of the creature within, are said to undergo a "coarctate" metamorphosis. Nearly all the diptera are examples of the coarctate insects.

Before we close the subject of parasites, it will be needful to give a brief account of one or two parasitic insects which possess points of peculiar interest in the habitations which they make, or in the places wherein they find their abode.

One of these insects is a rather pretty beetle, termed *Clerus alvearius.* In its perfect state it is innocent enough, but in its larval state it is so destructive among the hives, that all bee-keepers will do well to destroy every Clerus that they can catch. It is generally to be found on flowers, licking up their sweet juices by means of a brush-like apparatus attached to the mouth. The wing-cases of most of the species are bright red, barred or spotted with purple.

The larva is of a beautiful red, and is hatched from an egg placed in the cell occupied by the bee-grub. As soon as it is hatched, it proceeds to feed upon the bee-grub, and devours it. Unlike many insects with similar habits, it is not content with a single grub, but proceeds from cell to cell, devouring all their inhabitants. When it has eaten to the full, it conceals itself in the cell, and spins a cocoon of rather small dimensions in comparison with its own size. In process of time, it is developed into a perfect insect, and then breaks out of its cocoon and leaves the hive, secure from the bees, whose stings cannot penetrate the horny mail in which it is encased.

There is another beetle which is parasitic upon snails, and which, in its larval and pupal states, is only to be found within those molluscs. Its scientific name is *Drilus flavescens*, the latter name being given to it in honour of its yellow-tinted wing-cases, which present a pretty contrast with the black thorax. It is a little

beetle, scarcely exceeding a quarter of an inch in length, and is remarkable for the beautiful comb-like antennæ of the male. As for the female, she is so unlike her mate that she has been described as a different insect. She has no pretensions to beauty, and can scarcely be recognised as a beetle, her form being that of a mere soft-bodied grub. Moreover, the size of the two sexes is notably different. The male is, as has already been observed, only about a quarter of an inch long, while the female is not far from an inch in length, and is broader than the length of her mate, antennæ included.

This curious insect lives in the body of snails, the common banded snail of our gardens being its usual prey. When it is about to change into the perfect state, it makes a curious cocoon, of a fibrous substance, which has been well likened to common tobacco, the scent as well as the form increasing the resemblance. The grub or larva of this beetle bears a very great resemblance to the perfect female, and indeed is so similar that none but an entomologist could distinguish the two creatures. It is furnished with a number of false legs, as well as with a forked appendage at the end of the tail, by which it is enabled to force its way into the body of its victims. The head is pointed, and the jaws are very powerful.

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